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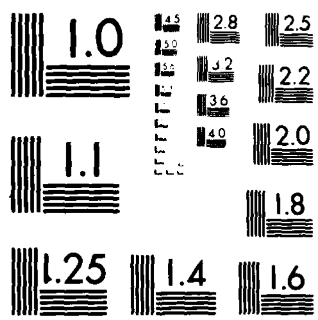

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DOT/FAA/RD-81/53

Systems Research &
Development Service
Washington, D.C. 20590

Modification of OE-258/URN Tactical Air Navigation (TACAN) Antenna Group

James D. Bain
RANTEC DIVISION
EMERSON ELECTRIC CO.
24003 Ventura Boulevard
Calabasas, CA 9139

July 1981

Final Report

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16. Abstract

The OE-258/URN TACAN Antenna Group has been modified to provide a remote monitor capability. This remote monitor meets the requirements of the IEEE-488 interface specification. A test set (controller) has been provided for use with the antenna group.

17. Key Words	18. Distribution Statement
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19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
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METRIC CONVERSION FACTORS

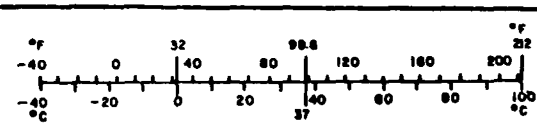
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

This final report describes the work done to modify the solid state OE-258/URN TACAN antenna group to remote monitoring of the Built-in-Test Equipment (BITE) including the following:

- Modification description
- Operation
- Installation of system
- Test results
- Conclusions and recommendations

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1.0 INTRODUCTION

1.1 Program Description

This program, conducted in accordance with the requirements of Department of Transportation (DOT) Contract Number DTF01-80-C-10148, was designed to provide a modified Rantec Tactical Air Navigation (TACAN) Antenna Group (Model OE-258/URN) and provide field support during testing at Federal Aviation Authority (FAA) Technical Center at Atlantic City, New Jersey. The antenna modifications were in accordance with the contract Statement of Work. These modifications provide a computer interface between the TACAN Antenna Group and the Second Generation Very High Frequency Omnidirectional Radio Range/Tactical Air Navigation (VORTAC) System. The interface is in accordance with the Institute of Electrical and Electronics Engineers (IEEE) - 488 standards. In addition, a test set duplicating the control and display functions of the VORTAC System was provided.

The antenna group furnished for this contract was transferred to the FAA from the United States (U.S.) Navy. No changes were made to the antenna. The modulation generator, however, was extensively modified and has been furnished as an engineering prototype for test and evaluation.

1.2 Antenna Group Description

The OE-258/URN TACAN Antenna Group is an all-band, solid-state, electronically modulated antenna for use with Tactical Air Navigation (TACAN) systems. It is used with the TACAN ground transponder for both transmission and reception, and provides the horizontally rotating 9-lobed pattern for the TACAN azimuth modulation characteristic. The use of electronic modulation deletes the requirement for any moving parts within the antenna, thus improving reliability and reducing power consumption. The Antenna Group consists of two major units, the Antenna and the Modulation Generator. This antenna is used in conjunction with a TACAN radio set (ground transponder) to provide a navigational signal for aircraft (distance and bearing for military users and distance for all users of the National Airspace). Figure 1-1 depicts this equipment relationship. Aircraft equipped with a companion TACAN interrogator unit derive slant-range distance to the ground beacon and bearing angle, referenced to majnetic north.

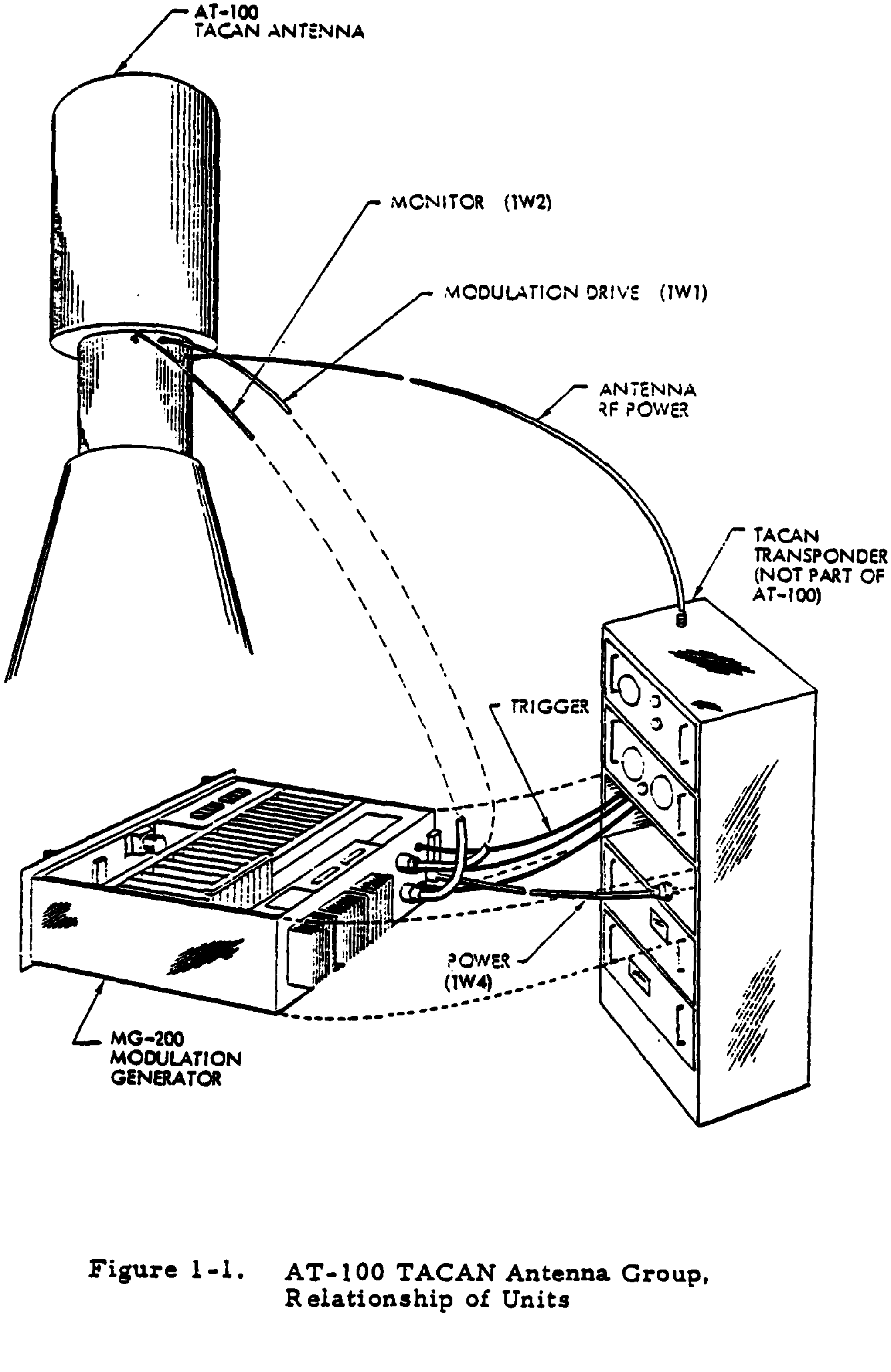

Figure 1-1. AT-100 TACAN Antenna Group, Relationship of Units

a. Antenna. The antenna unit is a cylindrical array approximately 84 inches high and 60 inches in diameter. It consists of 36 identical and equally spaced vertical radiating columns, providing for the transmission and reception of the pulse-paired rf signals. One antenna element is shown in Figure 1-2. The use of the cylindrical array configuration for the TACAN antenna presents several advantages:

(1) The use of cavity feed slots within the vertical arrays provides a very pure vertically polarized signal from the antenna, thus eliminating cross-polarization problems.

(2) Since the carrier, 15 Hz and 135 Hz modulation components are all radiated from the slots, they have the same basic radiation characteristics. Low-level signals below the horizon are maintained for all radiation components, thus minimizing ground reflection problems.

(3) Careful matching of the radiators and other rf components, together with the basic array geometry, permits single antenna operations over the entire TACAN band.

The cylindrical antenna base houses the modulators, power splitters, and associated circuitry and increases the overall height to 124 inches, with a total weight of approximately 850 pounds. Figure 1-3 shows the complete antenna with its environmentally protecting radome. Figure 1-4 diagrams the internal arrangement of the rf feed structure. In this figure:

A1 thru A36 are the vertical radiators.
A37 thru A39 are the azimuth feeds (12-way power dividers and PIN diode modulations).
A40 is the input, 3-way power divider.
A40A1 is the antenna-monitor printed circuit card.
J3/W40 provides the antenna rf input path.
J2/W42 provides the modulation drive input from the modulation generator.
J3/W41 provides the antenna monitor connections to the modulation generator from 1A40A1.

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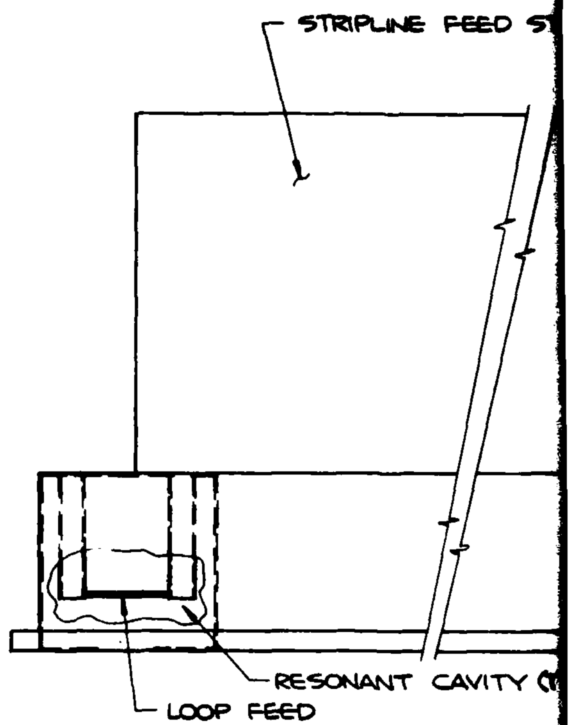
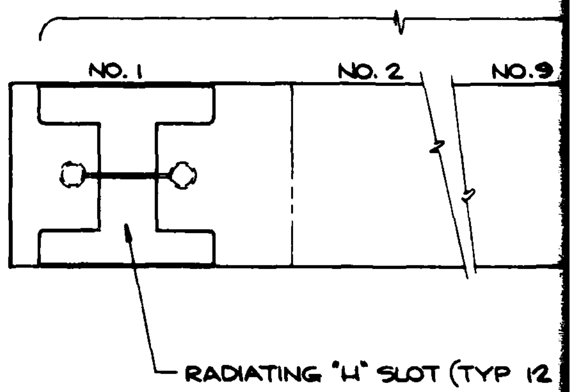


ELECTRICAL SPECIFICATIONS:

FREQUENCY RANGE 962 TO 1213 MHz
INPUT VSWR 1.50 MAX
FEED NETWORK STRIPLINE (NON RESISTIVE POWER DIVISION)
FEED DISTRIBUTION (BAND CENTER)

ELEMENT NO.	VOLTAGE	PHASE (DEG)
1	.141	-181
2	.209	-162
3	.260	-146
4	.309	-140
5	.371	-129
6	.452	-119
7	.525	-103
8	.661	-81
9	.882	-67
10	1.000	0
11	.507	+60
12	.166	+78

RADIATED SIGNAL POLARIZATION
LINEAR IN PLANE OF LONGITUDIAL AXIS



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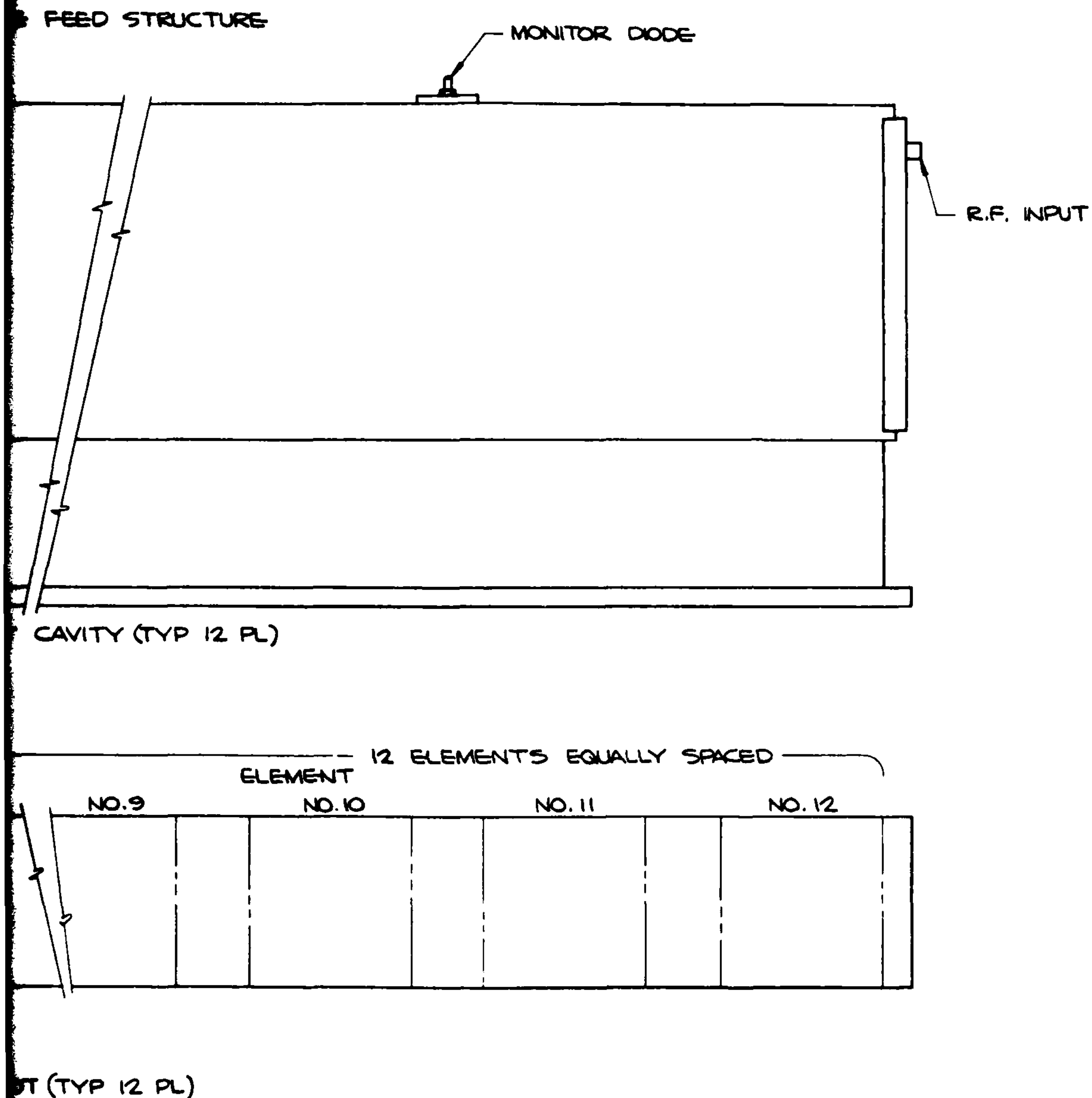

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INTERPRET PER MIL-STD-100
DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PLACE DECIMALS ±.03
3 PLACE DECIMALS ±.010
ANGULAR ±0°30'
BREAK SHARP EDGES .010 MAX
MACHINED FILLETS .010R MAX.

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CONTRACT NO.

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CALABASAS, CALIFORNIA 91302

RANTEC DIVISION EMERSON ELECTRIC CO

FIGURE 1-2

ANTENNA VERTICAL RADIATING ELEMENT

SIZE	CODE IDENT NO.		REV
D	04971		

SCALE SHEET

2

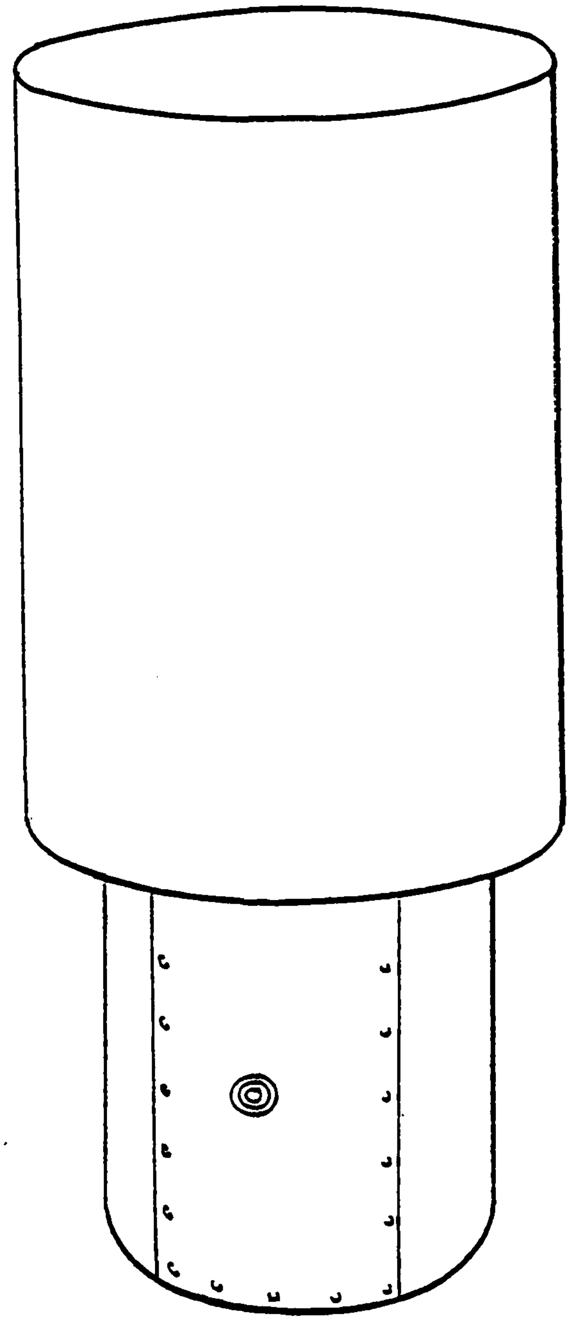
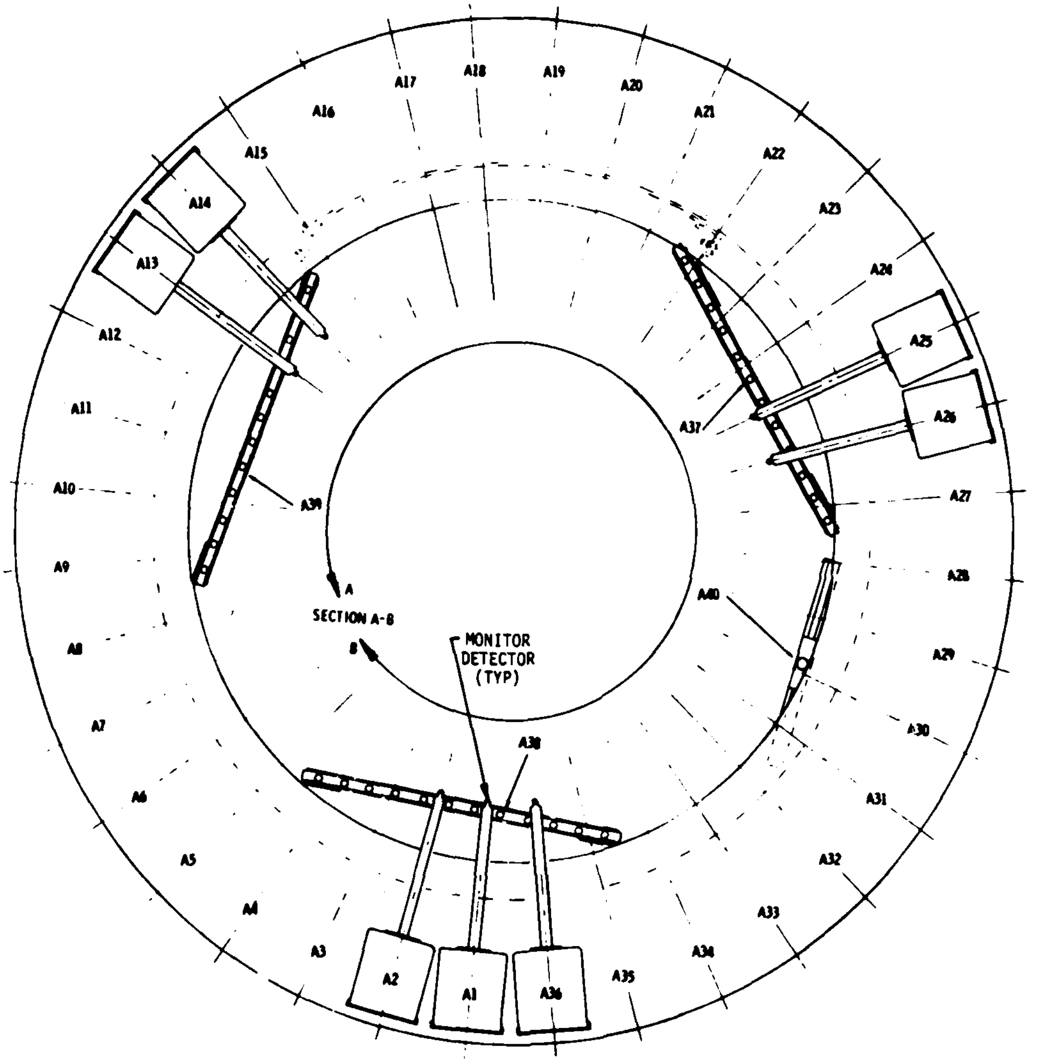
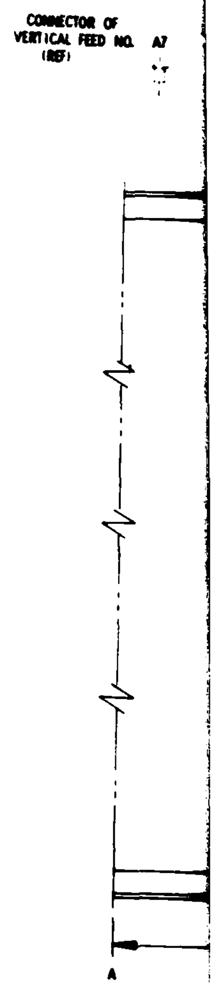
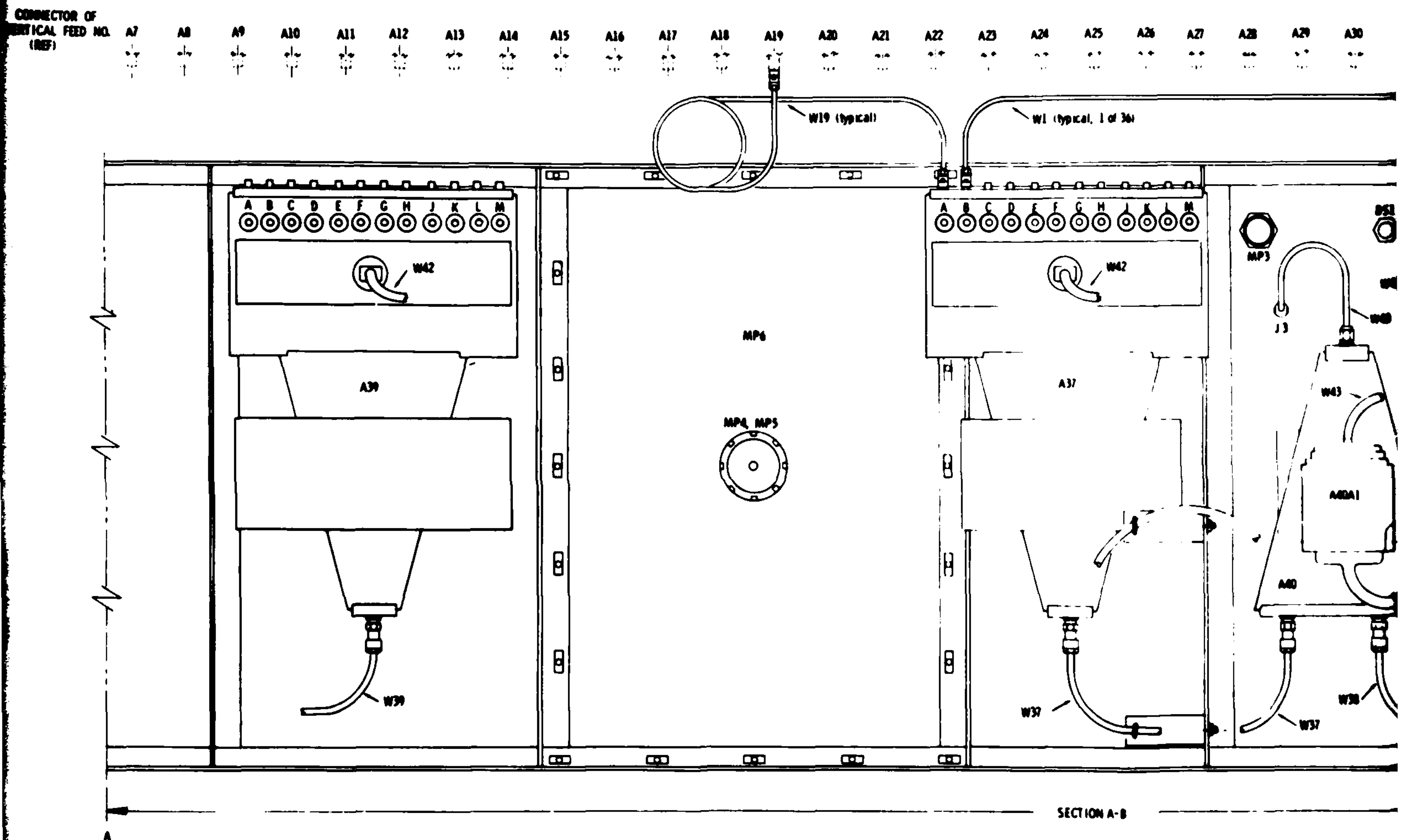


Figure 1-3. TACAN Antenna



TOP CUT-AWAY VIEW




CONNECTOR OF
ERTICAL FEED NO.
(REF)
A7
A8
A9
A10
A11
A12
A13
A14
A15
A16
A17
A18
A19
A20
A21
A22
A23
A24
A25
A26
A27
A28
A29
A30
W19 (typical)
W1 (typical, 1 of 36)
A B C D E F G H J K L M
W42
A39
MP6
MP4, MP5
A B C D E F G H J K L M
W42
A37
MP3
J3
W40
W43
A40A1
A40
W39
W37
W37
W38
SECTION A-B
A

2

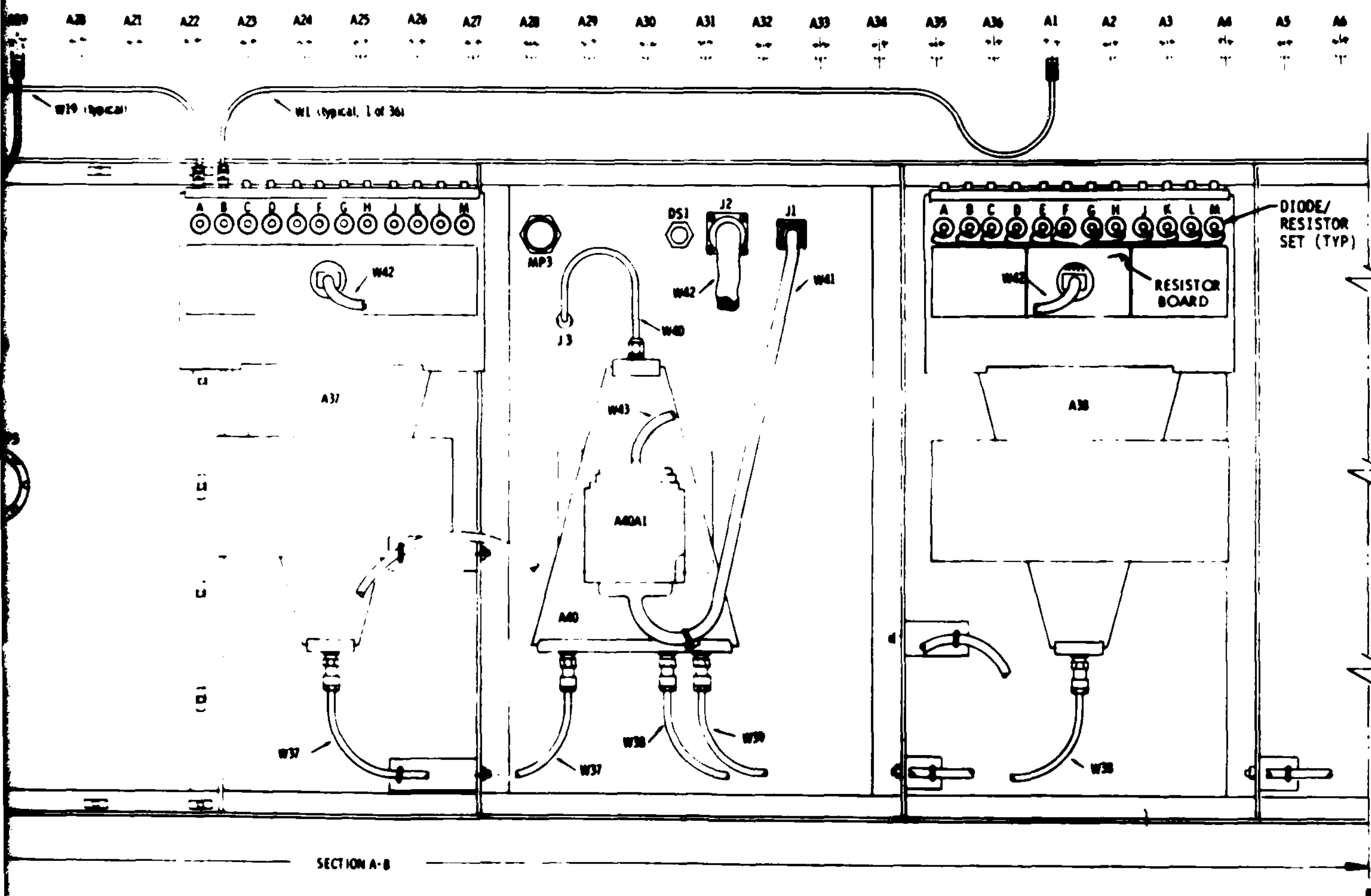


Figure 1-4. TACAN Antenna - RF Feed Structure

W43 provides signals from the 36 monitor diodes on each vertical divider (A1 through A36) to 1A40A1.
Other rf cables are self explanatory.

b. Modulation Generator. The modulation generator provides the 36 drive signals for PIN diode modulators in the antenna, which in turn produce the TACAN system's horizontally rotating pattern in space.

This unit also provides bipolar signals to the beacon transponder for timing the transmission of north and auxiliary reference bursts. A bipolar 1350 Hz signal is also supplied for the generation of a Morse-code station identification signal. Built-in-test equipment (BITE) circuits are provided to continuously monitor antenna group performance. The modulation generator is configured for mounting in a standard 19 inch wide rack, and has a front panel height of 8.75 inches, as shown in Figure 1-5. The unit is supplied in a self-contained cabinet with drawer slides.

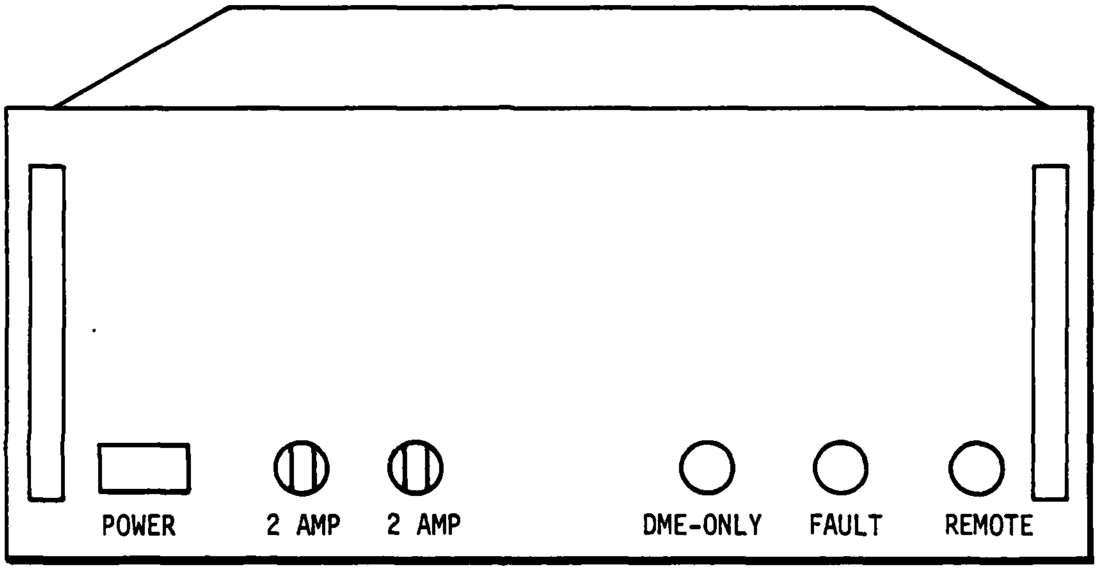


Figure 1-5. Modulation Generator

2.0 ANTENNA GROUP MODIFICATIONS

2.1 General

Modification of the TACAN Antenna Group was concerned only with the built-in test equipment (BITE) functions of the modulation generator and its interconnections to the computer interface. Thus no change was required in the antenna assembly or to the basic modulation drive and trigger signals from the modulation generator.

Physically the modulation generator front panel was modified such that it contains only a power switch, fuses, and FAULT, DME ONLY, and AUTO OPR lamp indicators. The rear panel was modified to contain the required interface connector. The interior was rearranged so that the internal panel contains certain of the operating and test switches formerly mounted on the front panel as shown in Figure 2-1.

The function of the various controls is listed below:

- Test sample select switch - Selects various critical wave forms for output on the test sample connector.
- Test sample connector - Outputs critical wave forms for display on oscilloscope.
- Operation switch - In 'Normal' the BITE system is scanning all 36 channels of modulation drive and antenna monitor signals. In 'TEST' the BITE system count is stopped and may be advanced one channel at a time using the -
- Advance switch
- Sync connector outputs a TTL pulse synchronous with the start of each BITE channel count.
- Aux trigger outputs a TTL pulse synchronous with the center of the bipolar auxiliary reference signal.
- Nor trigger - outputs a TTL pulse synchronous with the center of the bipolar north reference signal.
- Elapsed time - displays modulation generator operating time in hours.
- North align thumbwheel - permits alignment of the antenna to magnetic north.

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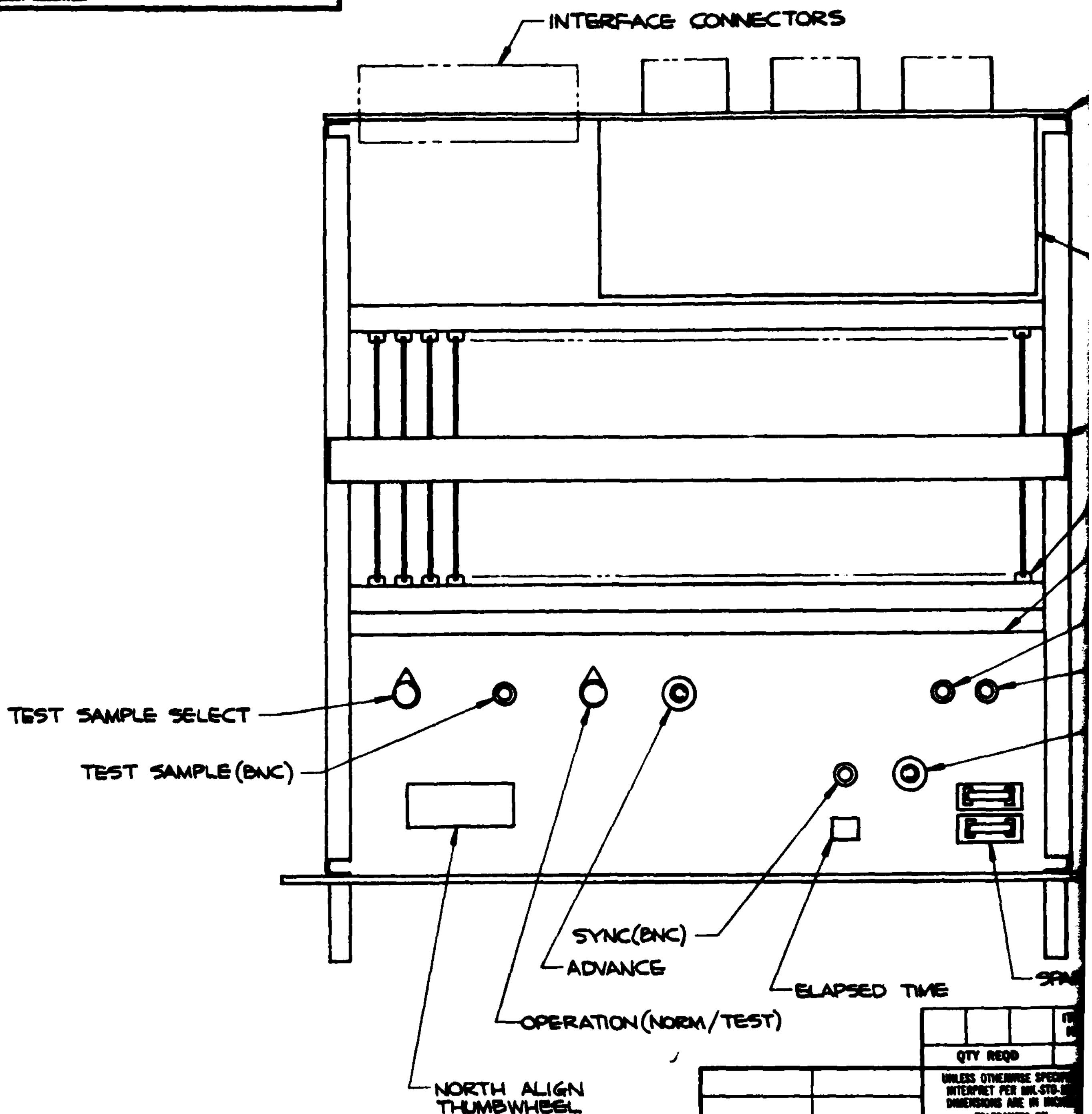

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3 PLACE DECIMALS ±.00
ANGULAR
BREAK SHARP EDGES .00
MACHINED FILLETS .010R

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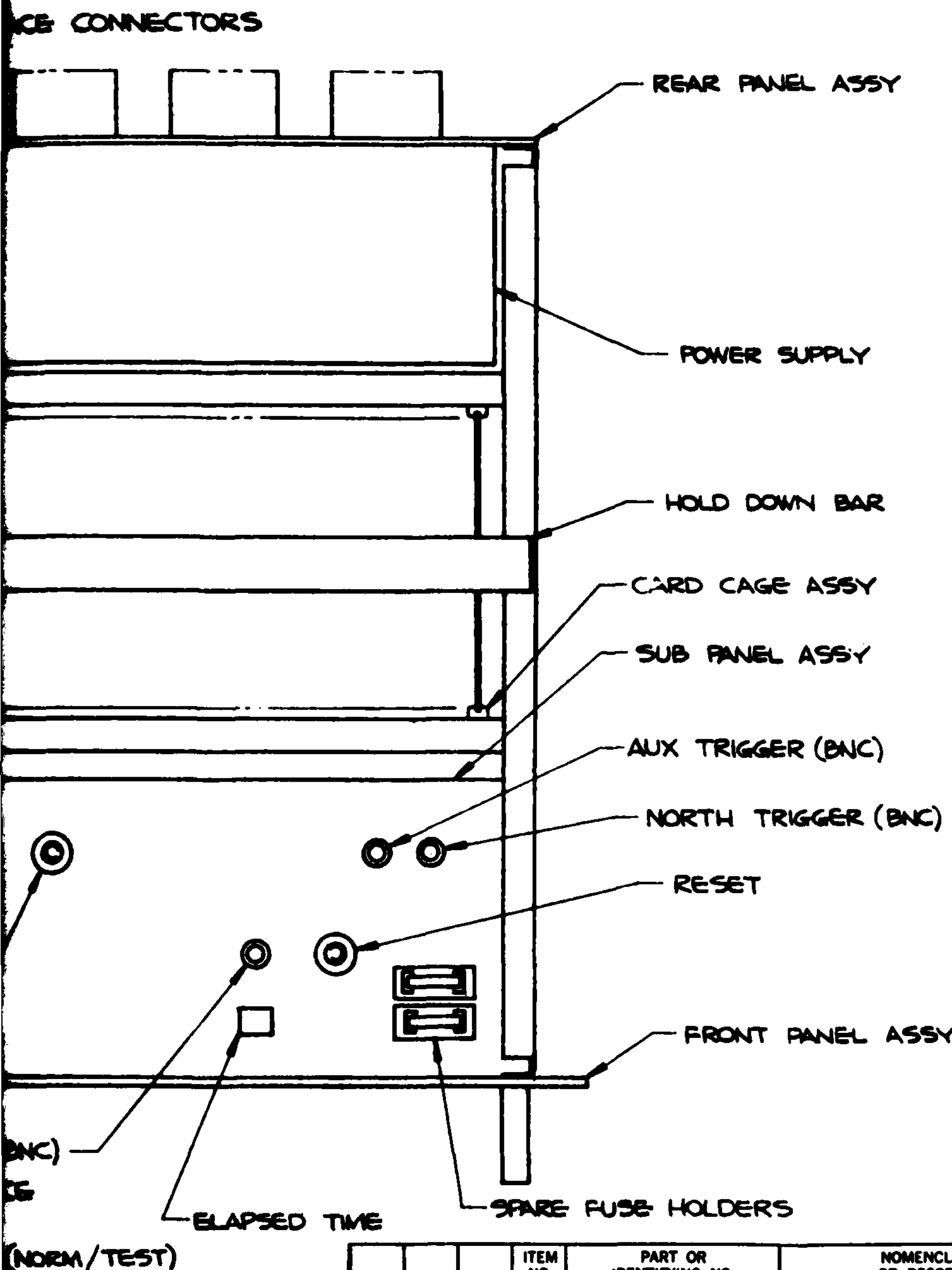

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APPLICATION	

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DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PLACE DECIMALS ±.03
3 PLACE DECIMALS ±.010
ANGULAR ±0°30'
BREAK SHARP EDGES .010 MAX
MACHINED FILLETS .010R MAX.

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rantec
CALABASAS CALIFORNIA 91302

RANTEC DIVISION
EMERSON ELECTRIC CO.

FIGURE 2-1
MODULATION GENERATOR-
INTERNAL CONFIGURATION

SIZE	CODE IDENT NO.		REV
C	04971		
SCALE		SHEET	

2

Circuit design for the required modifications required the replacement of six printed circuit cards (PCC's) and the addition of one PCC.

The replaced PC cards eliminate the circuitry required for (BITE) indicator lamps and beacon-shut-down circuitry which were a part of the original modulation generator. Added circuitry allows these BITE signals to be applied to the IEEE-488 bus. In addition the BITE circuitry for the trigger and antenna monitor signals were improved. The bipolar trigger signals are now monitored for both their positive and negative going voltage levels. The antenna monitor was changed to permit detection of both over and under modulation conditions and a column-radiated home level monitor was added. Finally, a monitor-diode bias monitor was added.

The additional PC card was required for implementation of the IEEE-488 interface circuitry. The total BITE/interface system is discussed in paragraph 2.2 and shown in Figure 2-2.

In accordance with the contract this modified modulation generator was furnished as an engineering prototype.

2.2 BITE System Concept

The BITE concept for the solid state antennas requires a different criteria than that required for a mechanically rotating antenna. The required parameters are discussed below together with their relationship to the solid state design.

2.2.1 Modulation Frequency

The modulation frequency is determined by crystal oscillators running at 3.456 MHz. Two identical oscillators are used and their frequency is compared to $\pm 0.35\%$. Thus the modulation and trigger frequency is accurately controlled. There can be no "WOW" or other perturbation to this basic frequency.

2.2.2 Trigger Signals

Since the trigger signals are generated electronically their basic frequency is assured. However, the BITE system is required to assure that the bipolar signals are present and that they occur in correct relationship and number.

2.2.3 Antenna Monitor

Since the solid-state antenna is an array, its' far-field pattern is a summation of the carrier and modulation from several of its 36 vertical columns. The accuracy of the bearing information is related within each column to:

- Phase of modulation signal
- Amplitude of modulation
- Phase of rf signal
- Amplitude of rf signal

The phase and amplitude of the modulation signal is controlled to a major extent by the 36 drive signals from the modulation generator. The BITE system uses a secondarily generated drive signal as a comparison in a summing network. The resultant 'generator-null' signal will detect errors of greater than 2 degrees or 0.6 dB in phase and amplitude. Only one column drive being outside these limits will have only a minor impact on antenna performance (see Appendix A).

The phase of the rf signal is determined by the rf path length through the antenna circuitry. This parameter is carefully controlled during antenna manufacture and is unlikely to change to any marked extent.

The rf paths themselves are either low-loss coaxial cable or strip-line. The only active components are the PIN diode modulators, the monitor diodes and the circuitry on the antenna monitor PCC (A40A1). Failure is, of course, more likely to occur in these active components. Present in-service antennas, however, indicate that these units are extremely reliable.

A monitor diode is connected to each of the 36 vertical arrays in the antenna. As processed in the modulation generator, these monitor signals will indicate both degradation of the rf signal level and degradation in the modulation signal. Here again the loss of one column does not seriously impact antenna performance.

The monitor diodes themselves are also checked (for bias level) to insure that failure of this element does not cause system false alarms.

2.3 BITE System Operation

The characteristics of the modified BITE system is described in the following paragraphs. Any detected fault will cause a system interrupt so that appropriate system analysis and a BEACON SHUT DOWN or DME ONLY decision can be made. A simplified block diagram of the BITE and interface circuit is shown in Figure 2-2. Complete data concerning the operation of this circuitry is contained in the Technical Manual Addendum (Rantec No. 11016-ATM) furnished with the modified antenna group.

2.3.1 Trigger Faults

The bipolar north, auxiliary, and tone signals are measured for the amplitude and presence of both the positive and negative going portion of their respective waveforms. These signals are also checked for the correct number of pulses as a function of time:

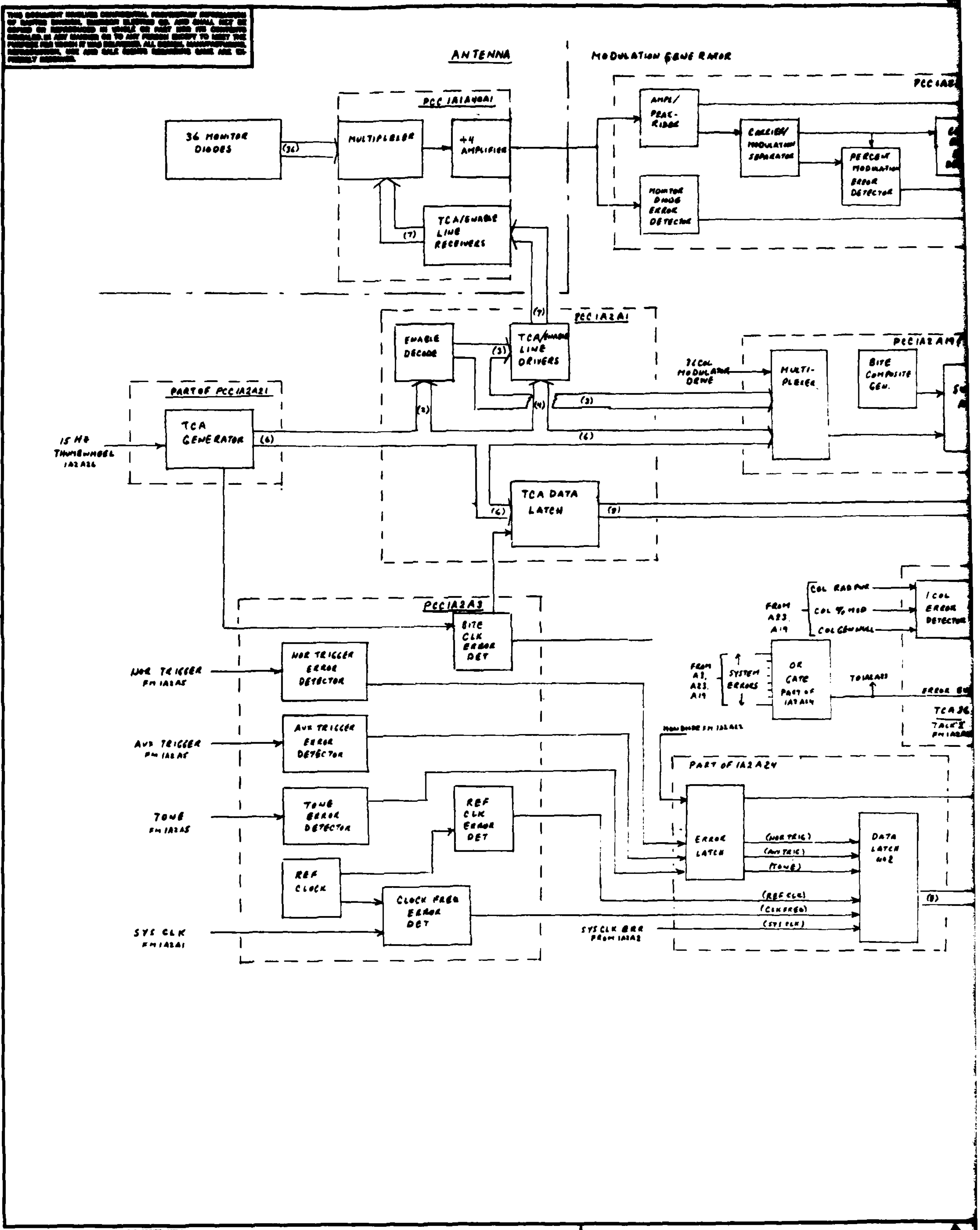
North	-	One and only one pulse between consecutive Auxiliary groups.
Auxiliary	-	Eight and only eight pulses between consecutive North pulses.
Tone	-	Ten and only ten pulses between the north pulse and the second auxiliary pulse.

Failure of the North or Auxiliary pulses is decoded in the test set as a hard error. Failure of the Tone signal is decoded as a soft failure.

2.3.2 Clock Faults

The presence of the system and reference clock signals is detected and are decoded as soft failures. These two signals are compared to test the clock frequency. Failure of this parameter is decoded as a hard failure.

Note: The failure of either clock disables the clock frequency test. Prompt repair action is therefore dictated.



ANTENNA
MODULATION GENERATOR
PCC 1A1A4A1
36 MONITOR DIODES
(36)
MULTIPLEXER
÷4 AMPLIFIER
TCA/ENABLE LINE RECEIVERS
(7)
AMPL/ PEAK-RIDER
CARRIER/ MODULATION SEPARATOR
PERCENT MODULATION ERROR DETECTOR
MONITOR DIODE ERROR DETECTOR
PCC 1A2A1
ENABLE DECODE
TCA/ENABLE LINE DRIVERS
(3)
(2)
(4)
(6)
(9)
PART OF PCC 1A2A21
TCA GENERATOR
15 Hz THUMBWHEEL 1A2A26
TCA DATA LATCH
MULTI-PLEXER
BITE COMPOSITE GEN.
PCC 1A2A3
BITE CLK ERROR DET
NAR TRIGGER ERROR DETECTOR
AUX TRIGGER ERROR DETECTOR
TONE ERROR DETECTOR
REF CLK ERROR DET
REF CLOCK
CLOCK FREQ ERROR DET
NAR TRIGGER FM 1A2A5
AUX TRIGGER FM 1A2A5
TONE FM 1A2A5
SYS CLK FM 1A2A1
FROM A23, A19
COL RAD PWR
COL % MOD
COL GEN FAIL
1 COL ERROR DETECTOR
FROM A3, A23, A19
SYSTEM ERRORS
OR GATE PART OF 1A2A19
PART OF 1A2A24
ERROR LATCH
(NAR TRIG)
(AUX TRIG)
(TONE)
(REF CLK)
(CLK FREQ)
(SYS CLK)
DATA LATCH NO 2
(8)
SYS CLK ERR FROM 1A2A2

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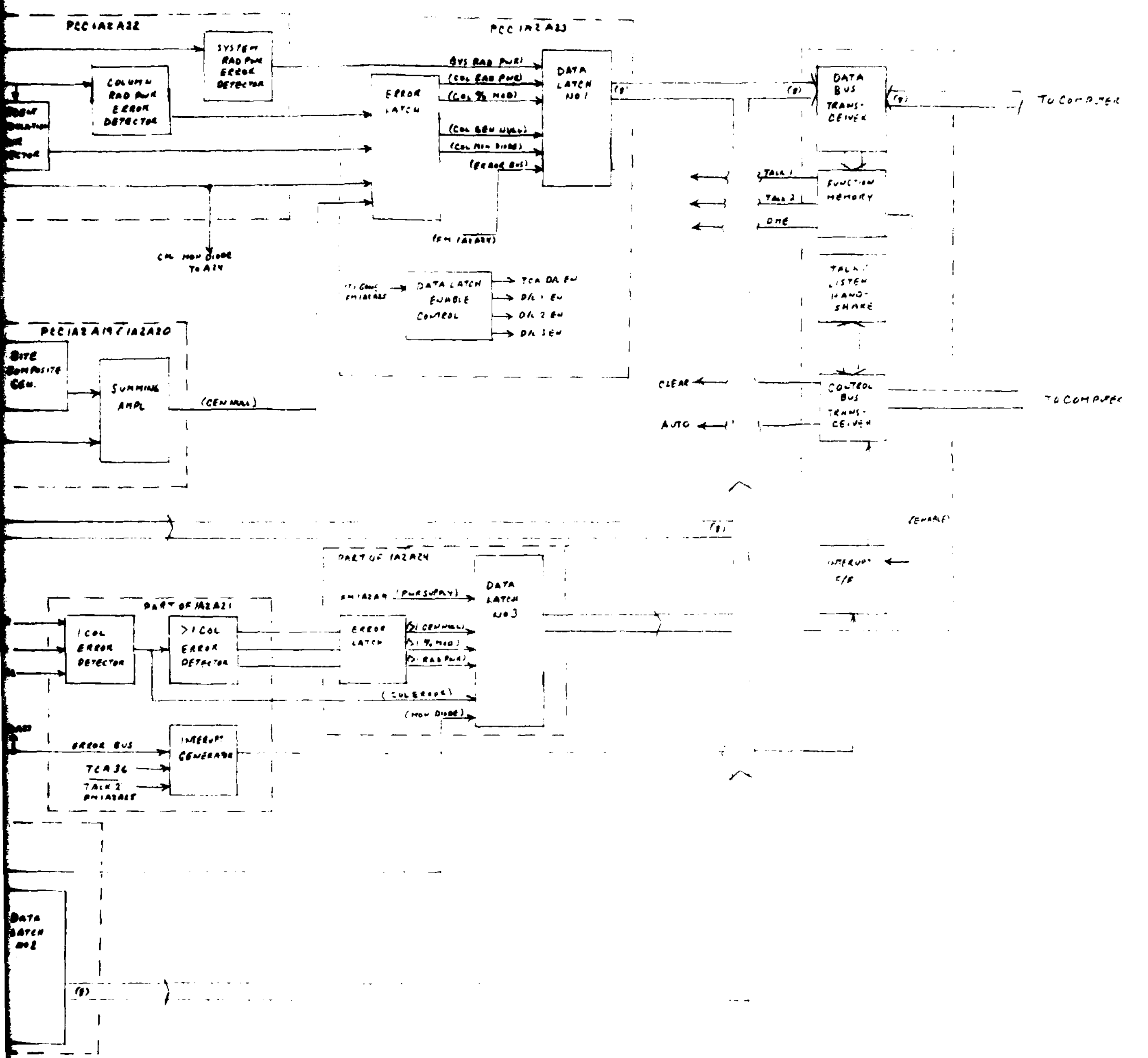

ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL	SPECIFICATION OR CODE IDENT

QTY REQD — LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED INTERPRET PER MIL-STD-100. DIMENSIONS ARE IN INCHES. TOLERANCES ON 2 PLACE DECIMALS ±.03; 3 PLACE DECIMALS ±.010; ANGULAR ±0°30'. BREAK SHARP EDGES .010 MAX. MACHINED FILLETS .010R MAX.

MATERIAL:

NEXT ASSEMBLY | USED ON

APPLICATION

CONTRACT NO.

DRAWN | DATE

CHECK

ENG

APPR

CALABASAS, CALIFORNIA 91302 — RANTEC DIVISION EMERSON ELECTRIC CO

SIMPLIFIED BLOCK DIAGRAM
BITE & INTERFACE SYSTEM
FIGURE 2-2

SIZE	CODE IDENT NO.		REV
D	04971	11015097	

SCALE | SHEET

2.3.3 Power Supply

The + and - 16 volt power supply output is monitored for a five percent deviation from nominal. A greater deviation is detected and decoded as a soft error.

2.3.4 Monitor Diode

The 36 monitor diodes for detecting the radiated signal characteristics of the 36 antenna columns are biased to achieve the required linearity and sensitivity. If a diode becomes open or shorted this bias voltage will change. This bias voltage level is detected by a comparator which will detect a fault for voltages outside preset limits. This fault is decoded as a soft failure.

In the test set, this parameter is detected on a column-by-column basis during a complete status scan. A diode fault in any column disables the antenna column radiated power and column percent modulation tests for that column. This will prevent false hard failures of the >1 column error parameters.

2.3.5 Generator Null

The drive signals to the 36 antenna column PIN-diode modulators are tested for phase and amplitude using a separately generated waveform. This test checks amplitude to within ±0.6 dB and phase to within ±2 degrees. A detected fault is decoded initially as a soft error. Should more than one column indicate a fault then a >1-column generator-null hard error is detected and decoded.

2.3.6 Antenna Parameters

The output of the 36 monitor diodes are utilized to detect column radiated power and column percent modulation faults. The column radiated power is initially detected and decoded as a soft failure for signal levels 3 dB below the preset level. Percent modulation is initially detected and decoded as a soft failure for levels less than 20 percent and greater than 60 percent for the composite 15 and 135 Hz modulation components. More-than-one-column faults are detected and decoded as appropriate >1 column hard errors.

2.3.7 System Radiated Power

The average carrier level for all 36 antenna columns is detected and decoded as a soft failure for levels 6 dB below the preset level. This fault disables the column radiated power and column percent modulation tests to prevent hard failures when the beacon is off.

2.3.8 BITE Clock

A 3.75 Hz clock is used to drive the 36 channel sequential fault detection system. The presence of the test channel address '1' bit is detected and its absence is decoded as a hard failure.

2.4 Computer Interface

2.4.1 General

The computer interface uses the IEEE-488 bus. Since only one interrupt (SRQ) line is present, then all antenna faults must result in interrupts and the BEACON SHUTDOWN analysis must be handled by the system computer and/or operator. The data transfer and interrupt operation are described in the following paragraphs.

2.4.2 Data Lines

The interface provides a parallel 8-bit data bus. The modulation generator therefore requires four 8-bit latches to handle the required data. At each test channel address these latches are clocked and will contain all of the antenna status information for that test address.

2.4.3 Data Transfer

The modulation generator is designed as a "TALKER" using two different secondary addresses. When placed in the TALK mode the contents of each of the four data latches is read in turn, their enable circuits being controlled and counted by the data transfer "hand-shake" process.

3.0 TEST SET

3.1 General

The test set provided with the TACAN antenna group is a Tektronix 4051 Graphics Computer which utilizes the IEEE-488 bus for interfacing with external periferal equipment. This unit has been programmed to provide operational and system test data similar to that which would be implemented in the Second Generation VORTAC System. The operation of the various monitor and test modes of this unit are described in the following paragraphs.

3.2 Executive Mode

Following initial system turn-on, the computer is placed in the executive mode by depressing USER DEFINABLE KEY '1'. In this mode the computer is in a loop which awaits a system interrupt. Such an interrupt is generated whenever a system fault is detected. When in this mode, the modulation generator AUTO lamp will be on and the computer display will be as shown in Figure 3-1. When a fault is detected the display changes to that shown in Figure 3-2 and appropriate errors will be indicated. For a column associated error the display will include an '↑' under the test channel address (TCA) of the first column error and the COLUMN ERROR entry will be preceded by an 'X'. When the fault is not column related, the '↑' will appear under non-column (NC) and the appropriate error will be indicated by a preceding 'X'. No individual column-related errors are displayed for this mode - a STATUS TEST must be performed to display these data.

Following this fault indication, the computer program stops and the operator is given the choice of various options to continue. It should be noted that the TACAN Antenna Group interrupt is disabled at this time and is reset only when the EXECUTIVE routine is restarted by depressing USER DEFINABLE KEY '1'. This is accomplished automatically following a data printout (see paragraph 3.6).

```
EXECUTIVE, SRQ ENABLED

TO RUN TESTS, U/D KEY:

    '2' STATUS TEST

    '3' BITE TEST

    '4' DME ONLY
```

Figure 3-1. Display for Executive Mode

```
                    ---TACAN ANTENNA STATUS---

COL ERRS---       000000000111111111122222222223333333N
                  123456789012345678901234567890123456C
TEST COL ADDR     ++++++++++++++++++++++++++++++++++++

HARD ERRORS---                          SOFT ERRORS---

        ->1 GEN NULL                            -SYS CLK
        ->1 RAD PWR                             -REF CLK
        ->1 PERCENT MOD                         -TONE
        - CLK FREQ                              -MON DIODE
        - NOR TRIG                              -COL ERROR
        - AUX TRIG                              -PWR SUP
                                                -SYS RAD PWR


SRQ DISABLED

TO CONTINUE, U/D KEY:

        '1' EXECUTIVE
        '2' STATUS TEST
        '3' BITE TEST
        '4' DME ONLY
        '5' PRINT DATA
```

Figure 3-2. Test Set - Data Matrix Display

3.3 Status Test Mode

The Status Test Mode is entered by depressing USER DEFINABLE KEY '2'. This mode may be entered following an interrupt to ascertain the complete status of the TACAN antenna group. It may also be entered directly from the Executive mode to verify that the TACAN antenna group operation is normal. This mode causes the computer display to be as shown in Figure 3-2. The test-channel address scan rate then changes from 267 msec to 1 second per channel. In the absence of an error, an '↑' will be sequentially displayed beneath each TCA address and then "TACAN ANT OPERATION NORMAL" will be displayed. For errors, the various column-related errors will be displayed beneath the appropriate TCA number. Hard and soft errors will be displayed following the TCA 36 count. Whenever this test is run, the TACAN antenna interrupt is disabled. A return to the Executive mode is required to reset the interrupt enable condition.

3.4 Bite Test Mode

The Bite Test Mode is entered by depressing USER DEFINABLE KEY '3'. This mode causes the various error latches in the modulation generator to be preset to the error condition. The computer will display Figure 3-2 and all of the fault indications except SYS RAD PWR and PWR SUP will show an 'X'. The TCA will indicate one arbitrary column and the column errors beneath it will show 'X's. the TACAN antenna interrupt is also disabled for this test. This test does not affect the normal operation of the antenna and may be performed at any time.

3.5 DME-Only Mode

The DME-Only Mode disables one of the primary oscillator-divider signals such that the bipolar triggers are turned off and the modulation drive is stopped at some arbitrary position. This operating mode is intended for use when a modulation generator, beacon, or antenna fault precludes operation in the normal TACAN mode. The TACAN antenna interrupt is disabled. Reset to normal is accomplished by returning to the Executive Mode. This operating mode causes the TCA data-latch 128 bit to be high. This bit is stored and decoded by the DATA PRINT operation (paragraph 3.6) to print out "DME ONLY mode".

3.6 Data-Print Mode

Whenever data is received by the computer bus due to an interrupt or a status scan, this data is available for transmission over a remote TTY line. Various printouts will occur depending upon the status (see Figure 3-3). This routine uses additional programming on the computer tape and uses the RS-232 serial output port. Upon completion of a data printout, the system will automatically return to the Executive mode.

A bite clock failure causes the TCA data latch 64 bit to be high. This bit is stored and decoded by the Data Print computer program to print out "BITE CLOCK FAILURE".

3.7 Error Decoding

3.7.1 General

Four tri-state eight-bit latches contain antenna TCA and status data. For each TCA the content of these latches is updated and is available for transmission over the computer 8-bit parallel data bus. The variable E is assigned by the computer software to read and store these bytes, using array sizes appropriate to the selected test mode. In the computer software, the variables A, B, C, and D are assigned the values of the four bytes. A will be equal to the current TCA and can be read directly. BITE CLK errors and DME ONLY status is also contained on this latch (see paragraph 3.4). The variables B, C and D are decoded by routines which ascertain which of the individual bits are high (no error) or low. These routines result in the display of 'X's for those bits which indicate errors. Table 3-1 contains the menu for the contents of the four bytes.

EXAMPLE 1.

```
----TACAN ANTENNA STATUS----
OPERATION NORMAL
----END OF DATA----
```

EXAMPLE 2.

```
----TACAN ANTENNA STATUS----
TCA  GEN   RAD  PERC   MON
     NULL  PWR  MOD    DIODE
 3          X    X
 7          X    X
----HARD ERRORS
>1 COL RAD PWR
>1 COL PERC MOD
----SOFT ERRORS
COL ERROR
----END OF DATA----
```

EXAMPLE 3.

```
----TACAN ANTENNA STATUS----
DME ONLY MODE
----END OF DATA----
```

Figure 3-3 Data Printout Examples

TABLE 3-1
DATA LATCH MENU

D/L No	Bit No	Decimal	Function	Reset
TCA (1A2A1)	1	1	TCA1 (Binary)	Each TCA
	2	2	TCA2 (Binary)	Each TCA
	3	4	TCA4 (Binary)	Each TCA
	4	8	TCA8 (Binary)	Each TCA
	5	16	TCA16 (Binary)	Each TCA
	6	32	TCA32 (Binary)	Each TCA
	7	64	BITE CLK ERROR (HI on error)	N/A
	8	128	DME ONLY (HI on DME only)	N/A
1 (1A2A23)	1	1	ERROR BUS (HI on error)	N/A
	2	2	COL MON DIODE (LO on error)	Each TCA
	3	4	SYS RAD PWR (LO on error)	N/A
	4	8	COL RAD PWR (LO on error)	Each TCA
	5	16	COL PERC MOD (LO on error)	Each TCA
	6	32	COL GEN NULL (LO on error)	Each TCA
	7	64	-Always HI-	N/A
	8	128	-Always HI-	N/A
2 (1A2A24)	1	1	REF CLK (LO on error)	TCA36/TCA1
	2	2	CLK FREQ (LO on error)	TCA36/TCA1
	3	4	NORTH (LO on error)	TCA36/TCA1
	4	8	AUX (LO on error)	TCA36/TCA1
	5	16	TONE (LO on error)	TCA36/TCA1
	6	32	SYS CLK (LO on error)	TCA36/TCA1
	7	64	-Always HI-	N/A
	8	128	-Always HI-	N/A
3 (1A2A24)	1	1	PWR SUP (LO on error)	N/A
	2	2	COL ERR (LO on error)	TCA36/TCA1
	3	4	MON DIODE (LO on error)	TCA36/TCA1

TABLE 3-1 (Cont'd)
DATA LATCH MENU

D/L No	Bit No	Decimal	Function	Reset
	4	8	>1 COL RAD PWR (LO on error)	TCA36/TCA1
	5	16	>1 COL PERC MOD (LO on error)	TCA36/TCA1
	6	32	>1 COL GEN NULL (LO on error)	TCA36/TCA1
	7	64	-Always HI-	N/A
	8	128	-Always HI-	N/A

3.7.2 STATUS TEST Operation

For a STATUS TEST, the variable E is assigned an array size of 36 x 4 and the status data is read and stored for each TCA starting at TCA1. During the operation of this routine the A and B values are continuously decoded such that the TCA count is denoted by an '↑' in the display and column error data may be denoted by an 'X' under the appropriate TCA (A SYS RAD PWR error may also be indicated at each TCA). The C and D values are decoded following TCA36. This results in program time being saved with no loss in data, since all errors contained in byte 3 and 4 are reset only on the TCA36 to TCA1 transition (see Table 3-1). Following a STATUS TEST, the raw data may be inspected by entering PRINT E then entering a carriage return (C/R) on the computer keyboard. The display for this operation, in the absence of a fault, would be:

1	254	255	255
2	254	255	255
3	254	255	255
↓			
36	254	255	255

The second byte is seen to be 254. This result is obtained since the 1 bit on this latch is the output of the ERROR BUS where a TTL LO indicates no errors (see Table 3-1). This byte = 254 at TCA36 is decoded by the computer as "OPERATION NORMAL".

3.7.3 EXECUTIVE Interrupt Operation

When in the EXECUTIVE mode an antenna error results in an interrupt at TCA36. In this instance the variable E is assigned an array size of 1 x 4 and only that data currently on the data latches is read. In the event that a column error has occurred, the TCA data latch will contain a number 1 less than the TCA at which the first error occurred. Specific column error data is not present (the column error latches going to data latch 1 are reset following each change in TCA). All other errors will still be present in bytes 3 and 4 since latches 2 and 3 are reset only by the transition from TCA36 to TCA1 and an interrupt disables this transition.

The fact that a column error (GEN NULL, COL PERC MOD or COL RAD PWR) has occurred is indicated by the SOFTFAIL - COL ERROR bit on data latch 3. Similarly a COL MON DIODE failure would be retained and displayed. If more than one column error has occurred the appropriate >1 COL error will be denoted (the ↑ still indicates the TCA of the first column where an error was detected). Complete failure data can be attained by performing the STATUS TEST routine. If the error is not column related the +1 computer function will result in TCA37 which places the ↑ under NC (non-column), and the appropriate error is indicated by an 'X' on the display.

3.8 Software

A complete listing of all program software is shown in Figures 3-4 through 3-6.

```
---RANTEC---
4 WBYTE @37,97:
5 INIT
6 GO TO 100
8 INIT
9 GO TO 500
12 PAGE
13 R=3
14 WBYTE @37,101:
15 GO TO 135
16 PAGE
17 WBYTE @37,99:
18 GO TO 1575
20 GO TO 4300
100 PAGE
105 PRINT "EXECUTIVE, SRQ ENABLED"
110 PRINT "J-TO RUN TESTS, U/D KEY:"
115 GOSUB 220
120 INIT
125 R=1
130 WBYTE @37,100:
135 WBYTE @37,96:
145 SET KEY
147 IF R=3 THEN 300
150 ON SRQ THEN 170
160 WAIT
165 GO TO 160
170 POLL F,G;5,1
180 GO TO F OF 300
190 END
200 PRINT "J-TO CONTINUE, U/D KEY:"
210 PRINT " '1'EXECUTIVE"
220 PRINT " '2'STATUS TEST"
230 PRINT " '3'BITE TEST"
240 PRINT " '4'DME ONLY"
250 RETURN
300 PAGE
320 GOSUB 1000
330 DELETE N,E
340 N=1
350 WBYTE @16,25:
360 WBYTE @69,97:
370 GOSUB 1500
380 GOSUB 2500
390 IF R=3 THEN 430
400 WBYTE @37,97:
410 WBYTE @63,95:
420 GO TO 615
430 PRINT "ALL'X' EXC PWR SUP, SYS HAD PWR"
440 PRINT "DEPRESS U/D KEY'1' TO RESET"
450 WAIT
```

Figure 3-4. Main Program (FIND 1)

```
500 PAGE
510 GOSUB 1000
520 DELETE N,E
522 N=36
524 FOR K=1 TO 1400
526 NEXT K
540 WBYTE @69,96:
560 GOSUB 1500
570 IF E(36,2)<>254 THEN 610
580 MOVE 0,30
590 PRINT "OPERATION NORMAL"
600 GO TO 620
610 GOSUB 2500
615 PRINT "SRC DISABLED"
620 GOSUB 200
630 PRINT " '5'PRINT DATA"
635 WBYTE @63,95:
640 END
1000 MOVE 0,92.5
1010 PRINT "I------TACAN ANTENNA STATUS-----"
1020 PRINT "J-COL ERRORS---I-000000000111111111122222222223333333N"
1030 PRINT "I-1234567890123456789012345678901234560"
1040 PRINT "TEST COL ADDR"
1050 PRINT "MON DIODE"
1060 PRINT "GEN NULL"
1070 PRINT "RAD PWR"
1080 PRINT "PERCENT MOD"
1090 PRINT "J-HARD ERRORS---I-I-SOFT ERRORS---"
1100 PRINT "  ->1 GEN NULLI-I-  -SYS CLK"
1110 PRINT "  ->1 RAD PWRI-I-  -REF CLK"
1120 PRINT "  ->1 PERCENT MODI-I-  -TONE"
1130 PRINT "  -CLK FREQI-I-  -MON DIODE"
1140 PRINT "  -NOR TRIGI-I-  -COL ERROR"
1150 PRINT "  -AUX TRIGI-I-  -PWR SUP"
1160 PRINT "I-I-  -SYS RAD PWR"
1170 MOVE 24,81.5
1180 DRAW 97,81.5
1190 MOVE 24,78.4
1200 DRAW 97,78.4
1210 MOVE 24,75.5
1220 DRAW 97,75.5
1230 MOVE 24,72.7
1240 DRAW 97,72.7
1250 MOVE 24,69.9
1260 DRAW 97,69.9
1265 MOVE 0,25
1270 RETURN
```

Figure 3-4. Main Program (FIND 1) - Cont'd

```
1500 DIM E(N,4)
1510 FOR I=1 TO N
1520 RBYTE E(I,1),E(I,2),E(I,3),E(I,4)
1530 A=ABS(E(I,1))
1535 IF A>128 THEN 1575
1540 IF A>64 THEN 1585
1545 IF N=36 THEN 1630
1550 A=A+1
1555 GO TO 1630
1575 PRINT "DME ONLY"
1580 GO TO 1590
1585 PRINT "BITE CLK ERR"
1590 WBYTE @63,95:
1592 N=1
1595 PRINT "DEPRESS U/D KEY'1' TO RESET"
1600 END
1630 B=ABS(E(I,2))
1640 C=ABS(E(I,3))
1650 D=ABS(E(I,4))
1660 P=30.5+A*1.792
1670 MOVE P,81.9
1680 PRINT ";"
1690 GOSUB 2000
1700 NEXT I
1720 RETURN
2000 IF B=255 THEN 2290
2010 B=B-224
2020 IF B=>0 THEN 2070
2030 MOVE P,75.6
2040 PRINT "X"
2060 B=B+32
2070 B=B-16
2080 IF B=>0 THEN 2130
2090 MOVE P,70
2100 PRINT "X"
2120 B=B+16
2130 B=B-8
2140 IF B=>0 THEN 2190
2150 MOVE P,72.8
2160 PRINT "X"
2180 B=B+8
2190 B=B-4
2200 IF B=>0 THEN 2250
2210 MOVE 0,44.7
2220 PRINT "I-I-X"
2240 B=B+4
2250 B=B-2
2260 IF B=>0 THEN 2290
2270 MOVE P,78.5
2280 PRINT "X"
2290 RETURN
```

Figure 3-4. Main Program (FIND 1) - Cont'd

```
2500 IF C=255 THEN 2850
2510 C=C-224
2520 IF C=>0 THEN 2570
2530 MOVE 0,61.5
2540 PRINT "I-I-X"
2560 C=C+32
2570 C=C-16
2580 IF C=>0 THEN 2630
2590 MOVE 0,55.9
2600 PRINT "I-I-X"
2620 C=C+16
2630 C=C-8
2640 IF C=>0 THEN 2690
2650 MOVE 0,47.4
2660 PRINT "X"
2680 C=C+8
2690 C=C-4
2700 IF C=>0 THEN 2750
2710 MOVE 0,50.3
2720 PRINT "X"
2740 C=C+4
2750 C=C-2
2760 IF C=>0 THEN 2810
2770 MOVE 0,53.1
2780 PRINT "X"
2800 C=C+2
2810 C=C-1
2820 IF C=0 THEN 2850
2830 MOVE 0,58.7
2840 PRINT "I-I-X"
2850 IF D=255 THEN 3200
2860 D=D-224
2870 IF D=>0 THEN 2920
2880 MOVE 0,61.5
2890 PRINT "X"
2910 D=D+32
2920 D=D-16
2930 IF D=>0 THEN 2960
2940 MOVE 0,55.9
2950 PRINT "X"
2970 D=D+16
2980 D=D-8
2990 IF D=>0 THEN 3040
```

Figure 3-4. Main Program (FIND 1) - Cont'd

```
3000 MOVE 0,58.7
3010 PRINT "X"
3030 D=D+6
3040 D=D-4
3050 IF D=>0 THEN 3100
3060 MOVE 0,53.1
3070 PRINT "I-I-X"
3090 D=D+4
3100 D=D-2
3110 IF D=>0 THEN 3160
3120 MOVE 0,50.3
3130 PRINT "I-I-X"
3150 D=D+2
3160 D=D-1
3170 IF D=>0 THEN 3200
3180 MOVE 0,47.4
3190 PRINT "I-I-X"
3200 MOVE 0,30
3210 RETURN
4300 FIND 3
4310 WRITE N
4320 FOR I=1 TO N
4330 WRITE E(I,1),E(I,2),E(I,3),E(I,4)
4340 NEXT I
4350 FIND 2
4360 OLD
```

Figure 3-4. Main Program (FIND 1) - Cont'd

```
4 GOSUB 100
5 FIND 1
6 OLD
7 END
100 FIND 2
105 READ @33:N
110 DIM E(N,4)
120 FOR I=1 TO N
130 READ @33:E(I,1),E(I,2),E(I,3),E(I,4)
140 NEXT I
150 PRINT @41,15:150
160 PRINT @37,26:1
170 PRINT @41:"J----TACAN ANTENNA STATUS---"
180 FOR J=1 TO N
190 IF E(J,1)<37 THEN 220
195 IF E(J,1)>128 THEN 690
200 PRINT @41:"BITE CLOCK FAILURE"
210 GO TO 660
220 NEXT J
230 IF E(N,2)<>254 THEN 260
240 PRINT @41:"OPERATION NORMAL"
250 GO TO 660
260 PRINT @41:"J----COLUMN ERRORS"
270 PRINT @41: USING 290:"TCA","GEN","RAD","PERC","MON"
280 PRINT @41: USING 290:" ","NULL","PWR","MOD","DIODE"
290 IMAGE 5(8A)
300 FOR I=1 TO N
305 IF N=1 THEN 320
307 IF I=36 THEN 320
310 IF E(I,2)>253 THEN 360
320 F=E(I,2)-224
330 GOSUB 1000
340 PRINT @41: USING 350:E(I,1),A$,C$,B$,D$
350 IMAGE 2D,10T,4(8A)
360 NEXT I
370 GOSUB 2000
380 PRINT @41:"J----HARD ERRORS"
390 IF C1=0 THEN 410
400 PRINT @41:">1 COL GEN NULL"
410 IF C3=0 THEN 430
420 PRINT @41:">1 COL RAD PWR"
```

Figure 3-5. Print Program (FIND 2)

```
1230 F=F-2
1240 IF F=>0 THEN 1280
1250 D$="X"
1260 F=F+2
1270 GO TO 1290
1280 D$=" "
1290 F=F-1
1300 IF F=>0 THEN 1330
1310 A6=1
1320 GO TO 1340
1330 A6=0
1340 RETURN
2000 F=E(N,3)-224
2010 IF F=>0 THEN 2060
2030 B1=1
2040 F=F+32
2050 GO TO 2070
2060 B1=0
2070 F=F-16
2080 IF F=>0 THEN 2120
2090 B2=1
2100 F=F+16
2110 GO TO 2130
2120 B2=0
2130 F=F-8
2140 IF F=>0 THEN 2180
2150 B3=1
2160 F=F+8
2170 GO TO 2190
2180 B3=0
2190 F=F-4
2200 IF F=>0 THEN 2240
2210 B4=1
2220 F=F+4
2230 GO TO 2250
2240 B4=0
2250 F=F-2
2260 IF F=>0 THEN 2300
2270 B5=1
2280 F=F+2
2290 GO TO 2310
2300 B5=0
2310 F=F-1
2320 IF F=0 THEN 2350
2330 B6=1
2340 GO TO 2360
2350 B6=0
```

Figure 3-5. Print Program (FIND 2) - Cont'd

```
430 IF C2=0 THEN 450
440 PRINT @41:">1 COL PERC MOD"
450 IF B5=0 THEN 470
460 PRINT @41:"CLK FREQ"
470 IF B4=0 THEN 490
480 PRINT @41:"NOR TRIG"
490 IF B3=0 THEN 510
500 PRINT @41:"AUX TRIG"
510 PRINT @41:"J----SOFT ERRORS"
520 IF B1=0 THEN 540
530 PRINT @41:"SYS CLK"
540 IF B6=0 THEN 560
550 PRINT @41:"REF CLK"
560 IF B2=0 THEN 580
570 PRINT @41:"TONE"
580 IF C4=0 THEN 600
590 PRINT @41:"MON DIODE"
600 IF C5=0 THEN 620
610 PRINT @41:"COL ERROR"
620 IF C6=0 THEN 640
630 PRINT @41:"PWR SUP"
640 IF A4=0 THEN 660
650 PRINT @41:"SYS RAD PWR"
660 PRINT @41:"J----END OF DATA---"
670 PRINT @37,26:0
680 RETURN
690 PRINT @41:"DME ONLY MODE"
700 GO TO 660
1000 IF F=>0 THEN 1040
1010 A$="X"
1020 F=F+32
1030 GO TO 1050
1040 A$=" "
1050 F=F-16
1060 IF F=>0 THEN 1100
1070 B$="X"
1080 F=F+16
1090 GO TO 1110
1100 B$=" "
1110 F=F-8
1120 IF F=>0 THEN 1160
1130 C$="X"
1140 F=F+8
1150 GO TO 1170
1160 C$=" "
1170 F=F-4
1180 IF F=>0 THEN 1220
1190 A4=1
1200 F=F+4
1210 GO TO 1230
1220 A4=0
```

Figure 3-5. Print Program (FIND 2) - Cont'd

```
2360 F=B(N,4)-224
2370 IF F=>0 THEN 2410
2380 C1=1
2390 F=F+32
2400 GO TO 2420
2410 C1=0
2420 F=F-16
2430 IF F=>0 THEN 2470
2440 C2=1
2450 F=F+16
2460 GO TO 2480
2470 C2=0
2480 F=F-8
2490 IF F=>0 THEN 2530
2500 C3=1
2510 F=F+8
2520 GO TO 2540
2530 C3=0
2540 F=F-4
2550 IF F=>0 THEN 2590
2560 C4=1
2570 F=F+4
2580 GO TO 2600
2590 C4=0
2600 F=F-2
2610 IF F=>0 THEN 2650
2620 C5=1
2630 F=F+2
2640 GO TO 2660
2650 C5=0
2660 F=F-1
2670 IF F=>0 THEN 2700
2680 C6=1
2690 GO TO 2710
2700 C6=0
2710 RETURN
```

Figure 3-5. Print Program (FIND 2) - Cont'd

```
---RANTEC---
4 INIT
5 PAGE
6 SET KEY
7 GO TO 100
8 GO TO 500
12 GO TO 700
16 RESTORE 3490
17 GO TO 300
20 RESTORE 3480
22 GO TO 300
24 PAGE
25 PRINT "DME ONLY, SRG DISABLED"
26 PRINT "DEPRESS U/D KEY'1' TO RESET"
27 END
28 RESTORE 3470
29 GO TO 300
100 PRINT "EXECUTIVE, SRG ENABLED"
110 PRINT "J-TO RUN TESTS, U/D KEY:"
120 GOSUB 240
130 ON SRG THEN 160
140 WAIT
150 GO TO 140
160 POLL E,F;5,1
170 GO TO E OF 300
180 RETURN
190 END
200 PRINT "J-TO CONTINUE, U/D KEY:"
210 PRINT " '1'EXECUTIVE"
240 PRINT " '2'STATUS TEST-NOMAL OPR"
260 PRINT " '3'BITE TEST"
270 PRINT " '4'SIMULATED COLUMN FAULT"
280 PRINT " '5'SIMULATED BITE CLK FAULT"
285 PRINT " '6'SIMULATED DME ONLY"
287 PRINT " '7'SIMULATED NON-COLUMN FAULT"
290 RETURN
300 PAGE
320 GOSUB 1000
330 DELETE N,E
340 N=1
370 GOSUB 1500
380 GOSUB 2500
390 PRINT "SRG DISABLED"
400 GOSUB 200
410 END
```

Figure 3-6. Demonstration Program (FIND 4)

```
500 PAGE
510 GOSUB 1000
520 DELETE N,E
530 N=36
540 RESTORE 3510
550 FOR J=1 TO 1000
555 NEXT J
560 GOSUB 1500
570 GOSUB 2500
580 GOSUB 1600
590 GOSUB 200
600 END
700 PAGE
720 GOSUB 1000
730 DELETE N,E
740 N=1
750 RESTORE 3500
770 GOSUB 1500
780 GOSUB 2500
790 PRINT "ALL'X' EXC PWR SUP,SYS RAD PWR"
800 PRINT "DEPRESS U/D KEY'1' TO RESET"
810 END
1000 MOVE 0,92.5
1010 PRINT "I------TACAN ANTENNA STATUS-----"
1020 PRINT "J-COL ERRORS---I-000000000111111111122222222223333333N"
1030 PRINT "I-123456789012345678901234567890123456C"
1040 PRINT "TEST COL ADDR"
1050 PRINT "MON DIODE"
1060 PRINT "GEN NULL"
1070 PRINT "RAD PWR"
1080 PRINT "PERCENT MOD"
1090 PRINT "J-HARD ERRORS---I-I-SOFT ERRORS---"
1100 PRINT "  ->1 GEN NULLI-I-  -SYS CLK"
1110 PRINT "  ->1 RAD PWRI-I-  -REF CLK"
1120 PRINT "  ->1 PERCENT MODI-I-  -TONE"
1130 PRINT "  -CLK FRECI-I-  -MON DIODE"
1140 PRINT "  -NOR TRIGI-I-  -COL ERROR"
1150 PRINT "  -AUX TRIGI-I-  -PWR SUP"
1160 PRINT "I-I-  -SYS RAD PWR"
1170 MOVE 24,81.5
1180 DRAW 97,81.5
1190 MOVE 24,78.4
1200 DRAW 97,78.4
1210 MOVE 24,75.5
1220 DRAW 97,75.5
1230 MOVE 24,72.7
1240 DRAW 97,72.7
1250 MOVE 24,69.9
1260 DRAW 97,69.9
1270 RETURN
```

Figure 3-6. Demonstration Program (FIND 4) - Cont'd

```
1500 FOR I=1 TO N
1520 READ A,B,C,D
1540 IF A<36 THEN 1660
1550 MOVE 0,30
1560 PRINT "BITE CLK ERR"
1570 PRINT "DEPRESS U/D KEY'1' TO RESET"
1580 END
1660 P=30.5+A*1.792
1670 MOVE P,81.9
1680 PRINT ";"
1690 GOSUB 2000
1692 FOR J=1 TO 200
1694 NEXT J
1700 NEXT I
1720 RETURN
1800 MOVE 0,40
1810 IF B<>0 THEN 1830
1820 PRINT "OPERATION NORMAL"
1825 PRINT "SRC DISABLED"
1830 RETURN
2000 IF B=127 THEN 2290
2010 B=B-96
2020 IF B=>0 THEN 2070
2030 MOVE P,75.6
2040 PRINT "X"
2050 IF B=-1 THEN 2290
2060 B=B+32
2070 B=B-16
2080 IF B=>0 THEN 2130
2090 MOVE P,70
2100 PRINT "X"
2110 IF B=-1 THEN 2290
2120 B=B+16
2130 B=B-8
2140 IF B=>0 THEN 2190
2150 MOVE P,72.8
2160 PRINT "X"
2170 IF B=-1 THEN 2290
2180 B=B+8
2190 B=B-4
2200 IF B=>0 THEN 2250
2210 MOVE 0,44.7
2220 PRINT "I-I-X"
2230 IF B=-1 THEN 2290
2240 B=B+4
2250 B=B-2
2260 IF B=>0 THEN 2290
2270 MOVE P,78.5
2280 PRINT "X"
2290 RETURN
```

Figure 3-6. Demonstration Program (FIND 4) - Cont'd

```
2500 IF C=127 THEN 2850
2510 C=C-96
2520 IF C=>0 THEN 2570
2530 MOVE 0,61.5
2540 PRINT "I-I-X"
2550 IF C=-1 THEN 2850
2560 C=C+32
2570 C=C-16
2580 IF C=>0 THEN 2630
2590 MOVE 0,55.9
2600 PRINT "I-I-X"
2610 IF C=-1 THEN 2850
2620 C=C+16
2630 C=C-8
2640 IF C=>0 THEN 2690
2650 MOVE 0,47.4
2660 PRINT "X"
2670 IF C=-1 THEN 2850
2680 C=C+8
2690 C=C-4
2700 IF C=>0 THEN 2750
2710 MOVE 0,50.3
2720 PRINT "X"
2730 IF C=-1 THEN 2850
2740 C=C+4
2750 C=C-2
2760 IF C=>0 THEN 2810
2770 MOVE 0,53.1
2780 PRINT "X"
2790 IF C=-1 THEN 2850
2800 C=C+2
2810 C=C-1
2820 IF C=0 THEN 2850
2830 MOVE 0,58.7
2840 PRINT "I-I-X"
2850 IF D=127 THEN 3200
2860 D=D-96
2870 IF D=>0 THEN 2920
2880 MOVE 0,61.5
2890 PRINT "X"
2900 IF D=-1 THEN 3200
2910 D=D+32
2920 D=D-16
2930 IF D=>0 THEN 2980
2940 MOVE 0,55.9
2950 PRINT "X"
2960 IF D=-1 THEN 3200
2970 D=D+16
2980 D=D-8
```

Figure 3-6. Demonstration Program (FIND 4) - Cont'd

```
2990 IF D=>C THEN 3040
3000 MOVE 0,58.7
3010 PRINT "X"
3020 IF D=-1 THEN 3200
3030 D=D+6
3040 D=D-4
3050 IF D=>0 THEN 3100
3060 MOVE 0,53.1
3070 PRINT "I-I-X"
3080 IF D=-1 THEN 3200
3090 D=D+4
3100 D=D-2
3110 IF D=>C THEN 3160
3120 MOVE 0,50.3
3130 PRINT "I-I-X"
3140 IF D=-1 THEN 3200
3150 D=D+2
3160 D=D-1
3170 IF D=>0 THEN 3200
3180 MOVE 0,47.4
3190 PRINT "I-I-X"
3200 MOVE 0,30
3210 RETURN
3470 DATA 37,127,127,126
3480 DATA 65,127,127,127
3490 DATA 5,127,127,117
3500 DATA 5,68,0,65
3510 DATA 1,127,127,127,2,127,127,127,3,127,127,127,4,127,127,127
3520 DATA 5,127,127,127,6,127,127,127,7,127,127,127,8,127,127,127
3530 DATA 9,127,127,127,10,127,127,127,11,127,127,127,12,127,127,127
3540 DATA 13,127,127,127,14,127,127,127,15,127,127,127,16,127,127,127
3550 DATA 17,127,127,127,18,127,127,127,19,127,127,127,20,127,127,127
3560 DATA 21,127,127,127,22,127,127,127,23,127,127,127,24,127,127,127
3570 DATA 25,127,127,127,26,127,127,127,27,127,127,127,28,127,127,127
3580 DATA 29,127,127,127,30,127,127,127,31,127,127,127,32,127,127,127
3590 DATA 33,127,127,127,34,127,127,127,35,127,127,127,36,126,127,127
```

Figure 3-6. Demonstration Program (FIND 4) - Cont'd

4.0 ANTENNA GROUP TESTS AND INSTALLATION

4.1 Acceptance Tests

Following completion of all modification, the antenna group was subjected to a complete acceptance test. This test was in accordance with Rantec documents 11002-ATP and 11016-ETP. The test report was furnished to the FAA as a part of Progress Report 4 (Rantec No. 11016 PR4).

4.2 Installation

The antenna was delivered to the FAA test center at Atlantic City and following the arrival of Rantec personnel, was installed at a VORTAC test facility. The antenna was installed on top of the existing VOR cone (see paragraph 6.d).

The modulation generator interconnecting cables and rf cable were routed through the VOR cone down into the equipment room. The modulation generator and test set were installed at a temporary location within the equipment room.

All equipment was then interconnected and the complete TACAN system was turned on. It was discovered that noise was causing a problem with the monitor-diode BITE circuit. The low pass filter on PCC1A2A22 used with the monitor-diode bias-level detector was modified to decrease its knee frequency. This cured the problem and will not effect the failure-detection capability of that BITE circuit.

Since no external monitor equipment or flight-check aircraft were available, no system test could be performed.

It was noted that the antenna monitor circuitry indicated an occasional antenna fault; however, the fault never persisted long enough to obtain column-related data on the test set. It was believed that the problem was associated with the monitor circuit and not the actual radiated signal. An attempt was made to fix the problem by reseting the low-percent modulation level comparator. This had only marginal success.

Since this problem was not encountered at Rantec, it is believed to be the result of system noise getting into the antenna monitor lines. A second PCCA22 was fabricated at Rantec incorporating a digital circuit to eliminate monitor sensitivity to short term noise bursts. Unfortunately the PCC could not be fully checked out at Rantec and was found to be inoperative at the FAA test center. It is felt, however, that the design is solid and should be incorporated in future modulation generators.

5.0 CONCLUSIONS

The modified TACAN Antenna Group has met the initial requirements of the program and now awaits test and evaluation at Atlantic City. It is believed the antenna group will meet all FAA requirements both with respect to performance and the operation of the newly designed interface.

6.0 RECOMMENDATIONS

As a result of the initial operation and installation of the TACAN antenna group there are several areas which need to be dealt with in an FAA/RANTEC design review meeting.

a. Upon initial turn-on the modulation generator comes on in the DME-ONLY mode. Initialization of full performance requires that the controller (test set) be connected and placed in its EXECUTIVE mode. It may be desirable that power-up of the system not require computer intervention. Such a change is very minor in nature.

b. There is some doubt that the Second Generation VORTAC requires a bipolar TONE signal. If this is the case, that circuitry and its associated BITE can be removed from the modulation generator.

c. The modulation generator meets the requirements of the IEEE-488 bus. The use of this interface with the VORTAC system will require programing of that system computer. The programing now accomplished in the test set should prove useful as a guide for that purpose; however, an interface between Rantec and the beacon system programmer should prove most beneficial.

d. The antenna connectors are presently located on the side of the antenna. For installation on the VOR cone, it would be desirable that these connections be made on the bottom of the antenna. At Atlantic City a hole was made through the adapter ring to accomplish the required cabling. It is desirable, of course, that the solution to this problem be made in a way which does not impact the antenna seal.

e. Some system of ordering the antenna/modulation generator interconnecting cables is required. It was noted in Atlantic City that at least three different installation configurations exist which will require different cable lengths.

f. Incorporate a noise immunity circuit in the antenna monitor electronics (see paragraph 4.2).

Since this problem was not encountered at Rantec, it is believed to be the result of system noise getting into the antenna monitor lines. A second PCCA22 was fabricated at Rantec incorporating a digital circuit to eliminate monitor sensitivity to short term noise bursts. Unfortunately the PCC could not be fully checked out at Rantec and was found to be inoperative at the FAA test center. It is felt, however, that the design is solid and should be incorporated in future modulation generators.

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f. Incorporate a noise immunity circuit in the antenna monitor electronics (see paragraph 4.2).

7.0 REFERENCE DOCUMENTS

The following documents are referenced here as applicable to this project:

Statement of Work - Department of Transportation (DOT)
Contract No. DTF01-80-C-10148

Technical Manual - OE-258/URN TACAN Antenna Group
Rantec Document No. 11002-TM-C

Technical Manual Addendum
Rantec Document No. 11016-TMA

APPENDIX A

ANTENNA FAULT TESTS

In an effort to gain further insight into antenna group performance as a function of various faults, a series of patterns were obtained for the 135 Hz phase-track (bearing) error, using various faults. These tests were performed in Rantec's 120-foot anechoic chamber using the specialized test equipment designed for TACAN antenna acceptance tests. Patterns are shown in Figures A-1 through A-12. The following description deals with these patterns:

A-1	Normal pattern.
A-2	Gain of drive amplifier changed slightly - no significant pattern change.
A-3	Short output of drive amplifier - $\pm 2^{\circ}$ peak error on either side of faulty drive.
A-4	Short PIN diode modulator - $\pm 2^{\circ}$ peak error on either side of shorted modulator.
A-5	1K resistor across PIN diode modulator (test of PIN diode leakage) - no significant change.
A-6	100Ω resistor across PIN diode modulator (increased leakage) - $\pm 2^{\circ}$ peak error on either side of affected modulator.
A-7	PIN diode removed (open) - $\pm 2^{\circ}$ error on either side of affected drive.
A-8	RF cable removed (no carrier) - $\pm 2^{\circ}$ error on either side of affected column.
A-9	Adjacent PIN diode shorted (two column error) $\pm 2.5^{\circ}$ error on either side of adjacent column.

A-10 PIN diodes shorted, two columns 30° apart (two column error) - ±2.2° error over broader section.

A-11 PIN diodes shorted, two columns 80° apart ±1.8° errors at both columns.

A-12 PIN diodes shorted, two columns 180° apart (both outputs of one push-pull modulator) - ±2.2° error with roughness throughout pattern.

Variable 135 HZ φ vs AZIMUTH

Antenna S/N 084

Generator S/N 065

Fixed Angle ELEV. = 90° Y-HI

Compensation Switches

Comments: AVG 4.77

Frequency 1087 MHZ

Operator RZ

Witness

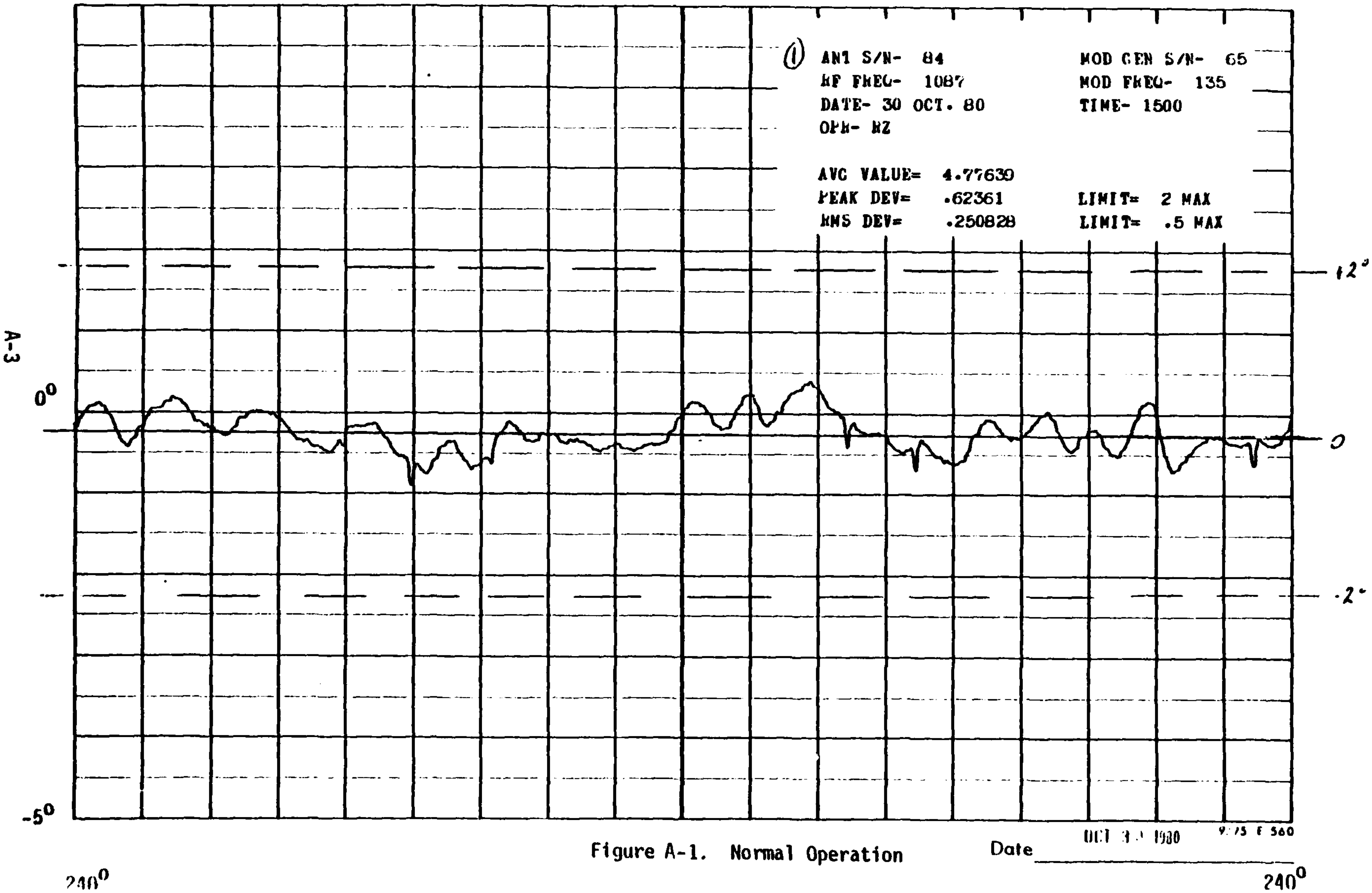


Figure A-1. Normal Operation

Date OCT 30 1980

Variable 135 Hz ϕ vs Az　　Fixed Angle EL=90　　Frequency 1087 MHz

Antenna S/N 084　　Compensation Switches Y H1　　Operator RZ

Generator S/N 065　　Comments: R15 on A10 = 40.2K　　Witness

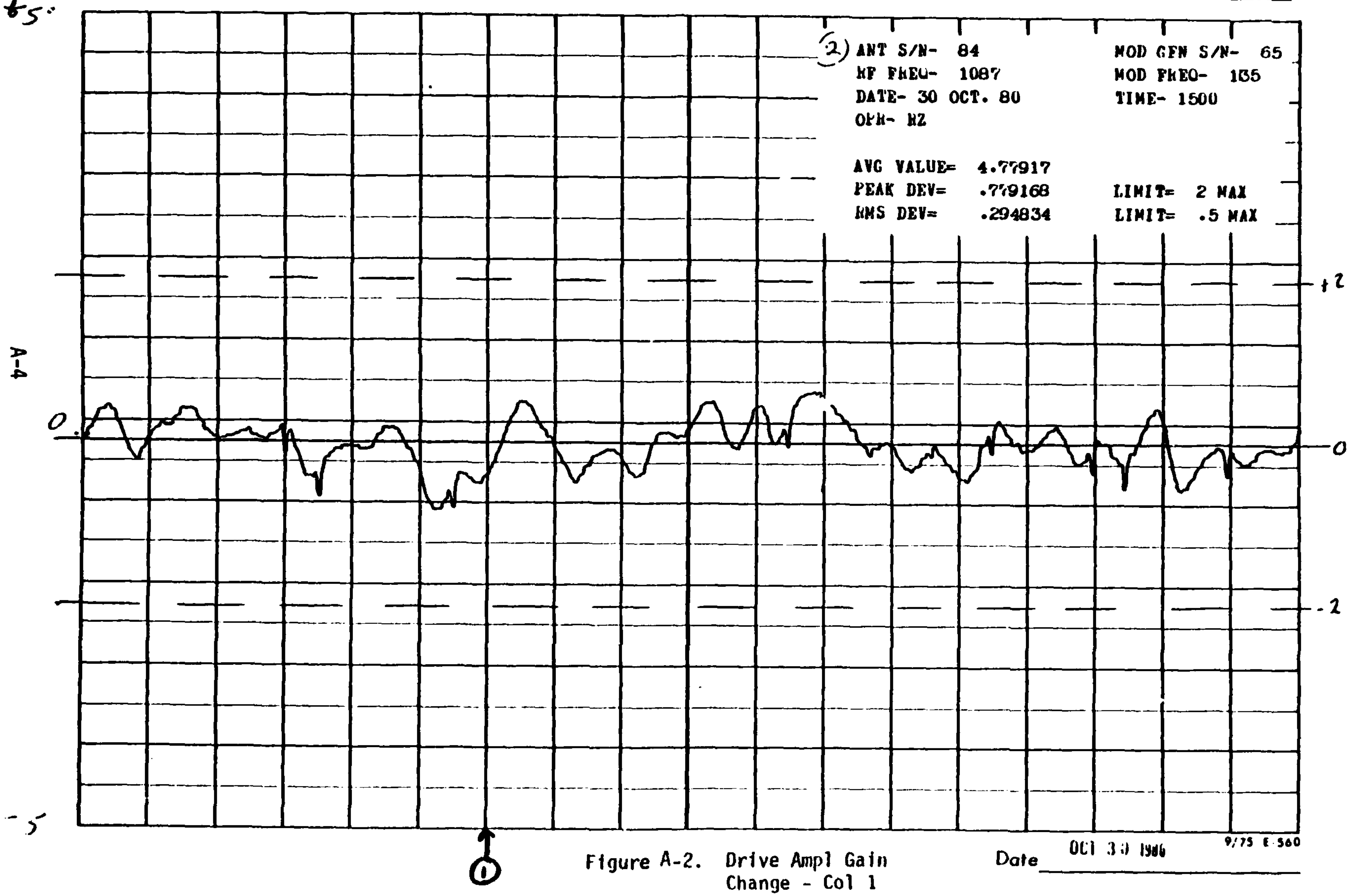
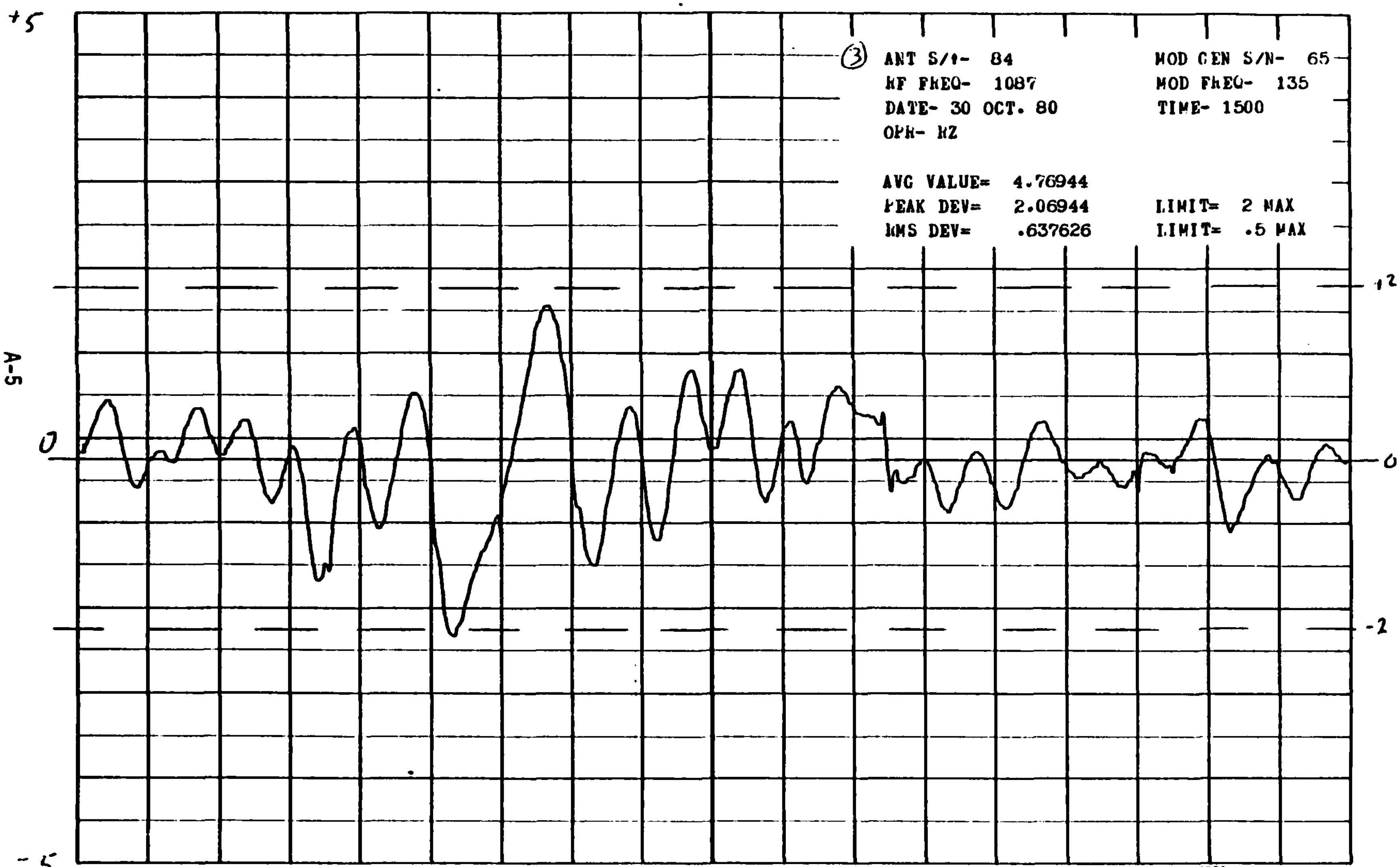


Figure A-2. Drive Ampl Gain Change - Col 1

Date OCT 30 1980

Variable 135Hz ϕ vs Az | Fixed Angle EL - 90° | Frequency 1087 MHz
Antenna S/N 084 | Compensation Switches Y-Hi | Operator RZ
Generator S/N 065 | Comments: Short Drive Col 1 | Witness

(3)



(1) Figure A-3. Shorted Mod Drive - Col 1

Date

Variable 135Hz ϕ vs Az | Fixed Angle EL=90° | Frequency 1087 MHz (4)

Antenna S/N 084 | Compensation Switches Y-H1 | Operator RZ

Generator S/N 065 | Comments: Pin Diode Short Col 1 | Witness

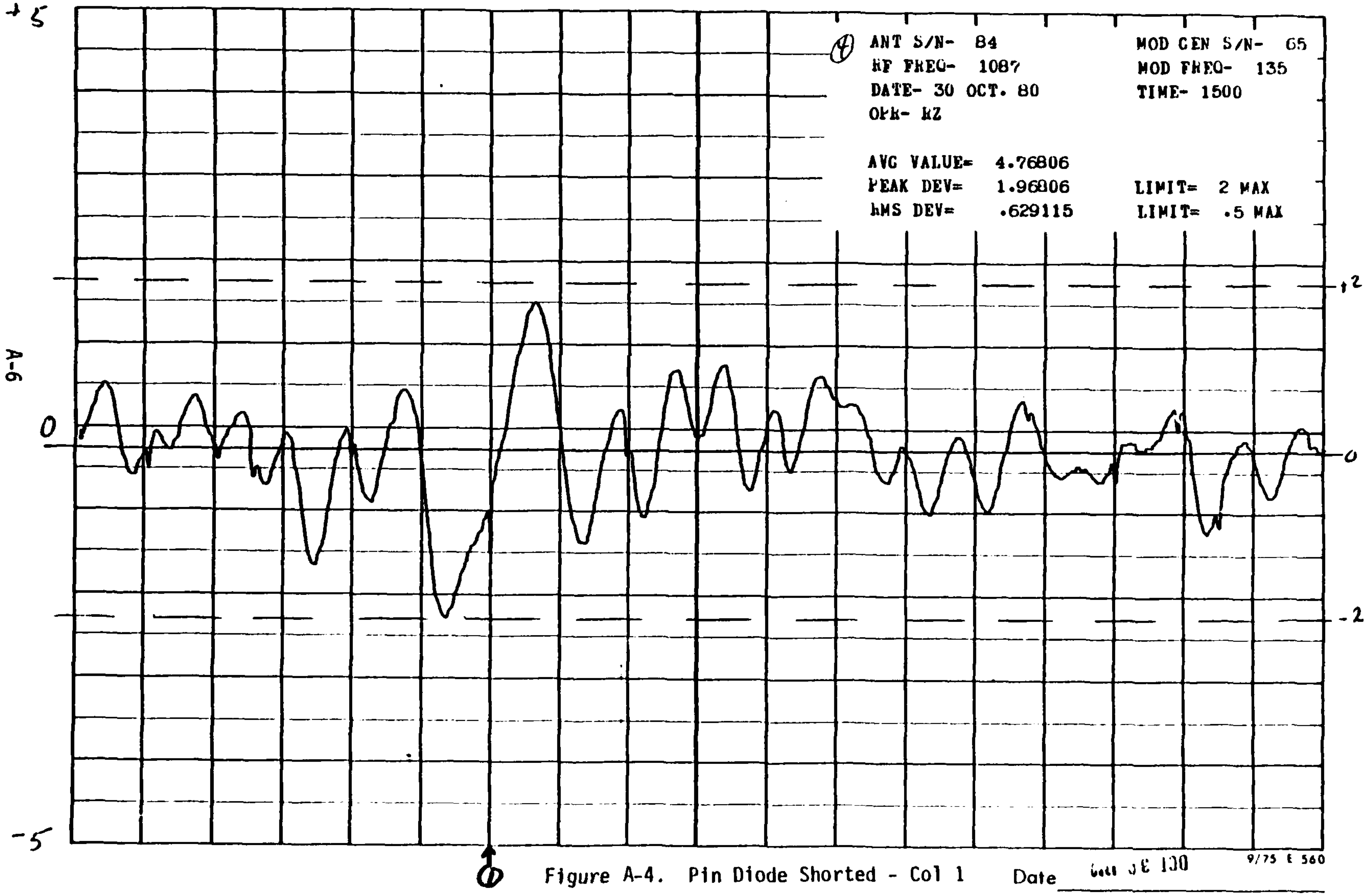


Figure A-4. Pin Diode Shorted - Col 1 Date

9/75 E 560

(5)

Variable 135 Hz ϕ vs Az
Antenna S/N 084
Generator S/N 065

Fixed Angle EL = 90°
Compensation Switches Y H1
Comments: 1 K~ Across Col #1

Frequency 1087 MHz
Operator RZ
Witness

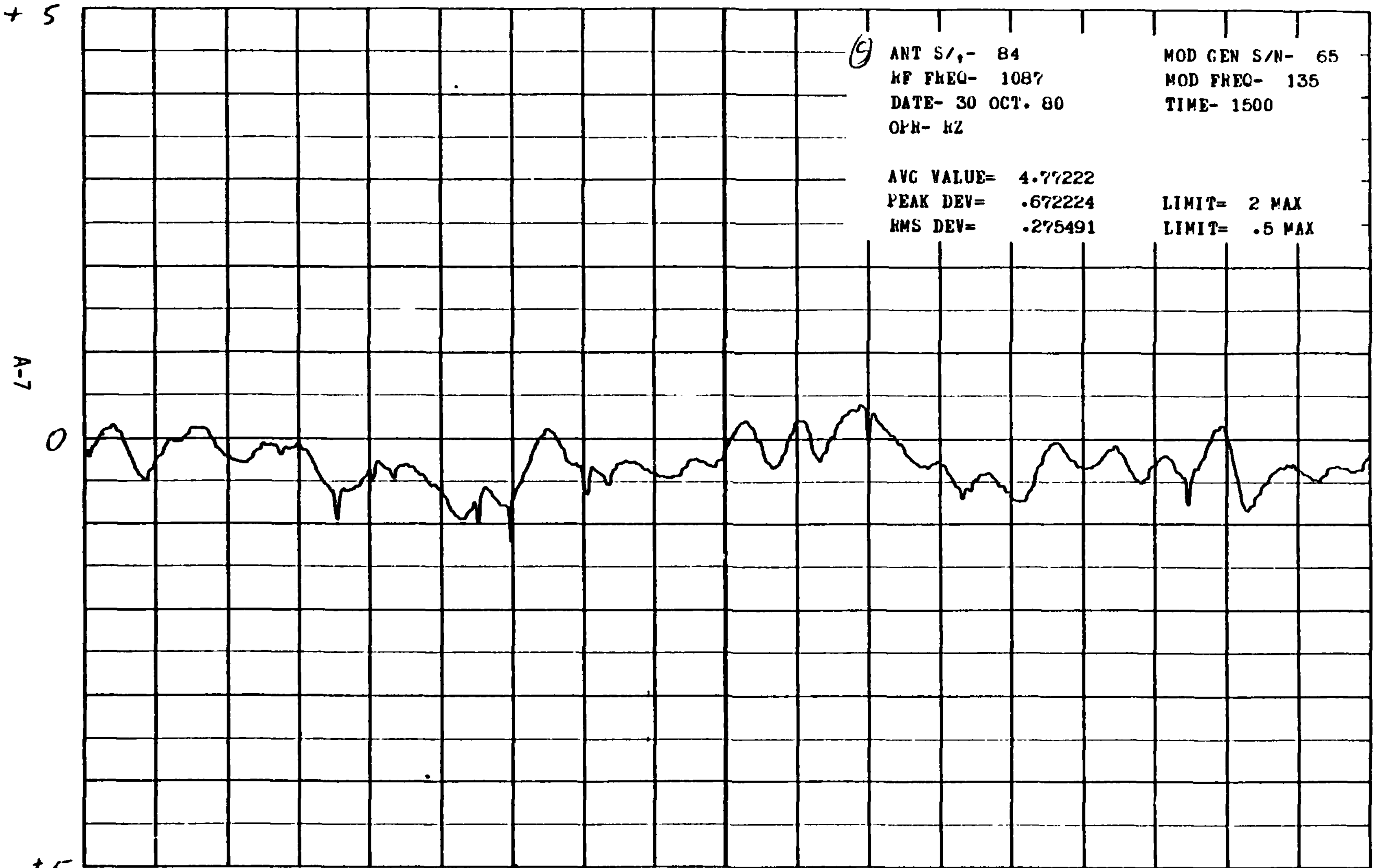


Figure A-5. 1K Across Pin Diode - Col 1

Date OCT 30 1980

(6)

Variable 135 Hz ϕ vs Az | Fixed Angle EL = 90° | Frequency 1087 MHz

Antenna S/N 084 | Compensation Switches Y-HI | Operator RZ

Generator S/N 065 | Comments: 100 Ω Across Cor #1 | Witness

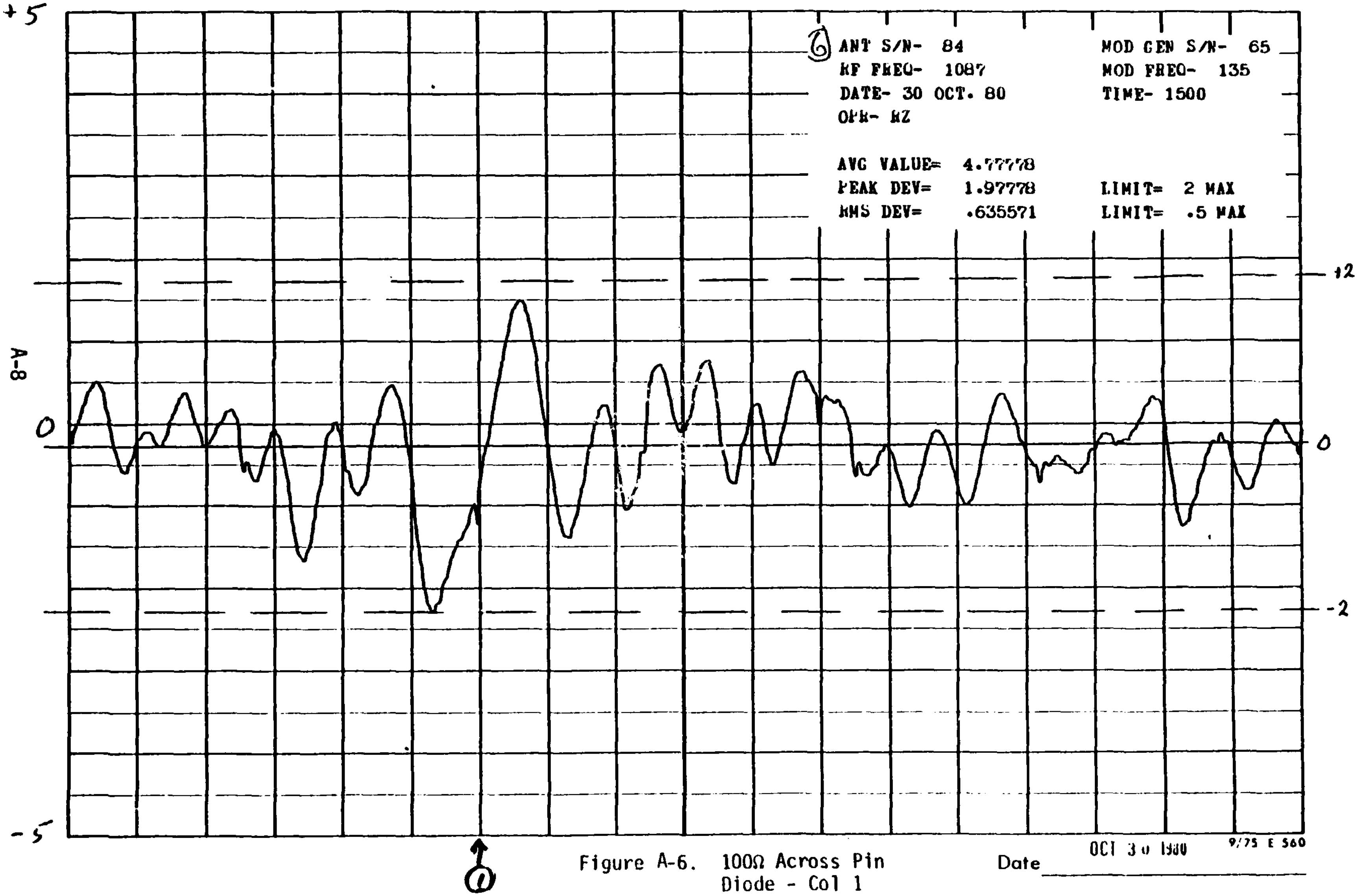


Figure A-6. 100Ω Across Pin Diode - Col 1

Date OCT 30 1980

9/75 E 560

7

Variable 135 Hz ∅ vs Hz Fixed Angle El = 90 Frequency 1087

Antenna S/N 084 Compensation Switches Operator PA

Generator S/N 065 Comments: Pin Diode Removed Col #1 Witness

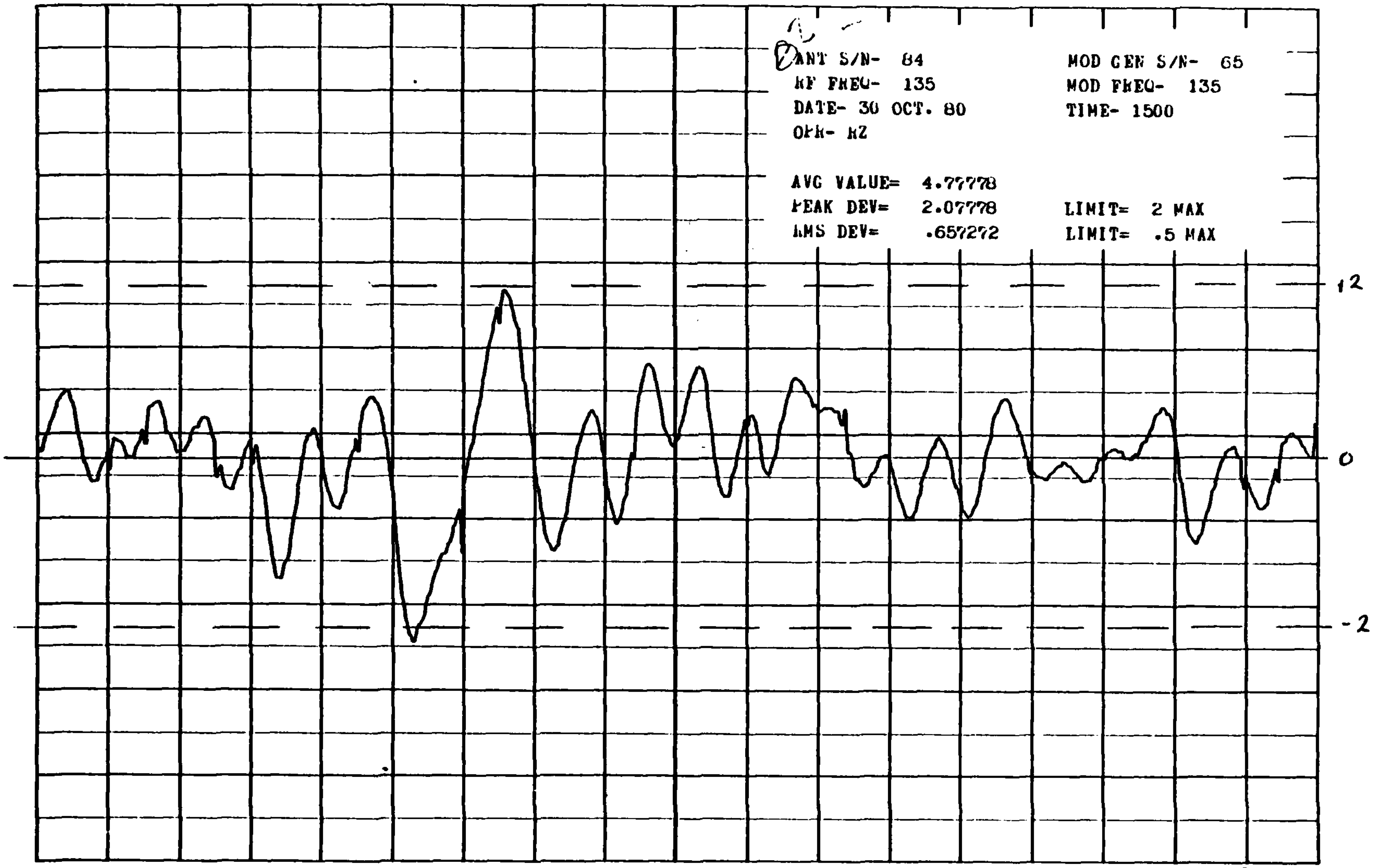


Figure A-7. Pin Diode Removed - Col 1

Date

(8)

Variable 135 Hz vs
Antenna S/N 084
Generator S/N 065

Fixed Angle EL = 90°
Compensation Switches y H:
Comments: Col #1 Cable disconnected

Frequency 1087
Operator JA
Witness

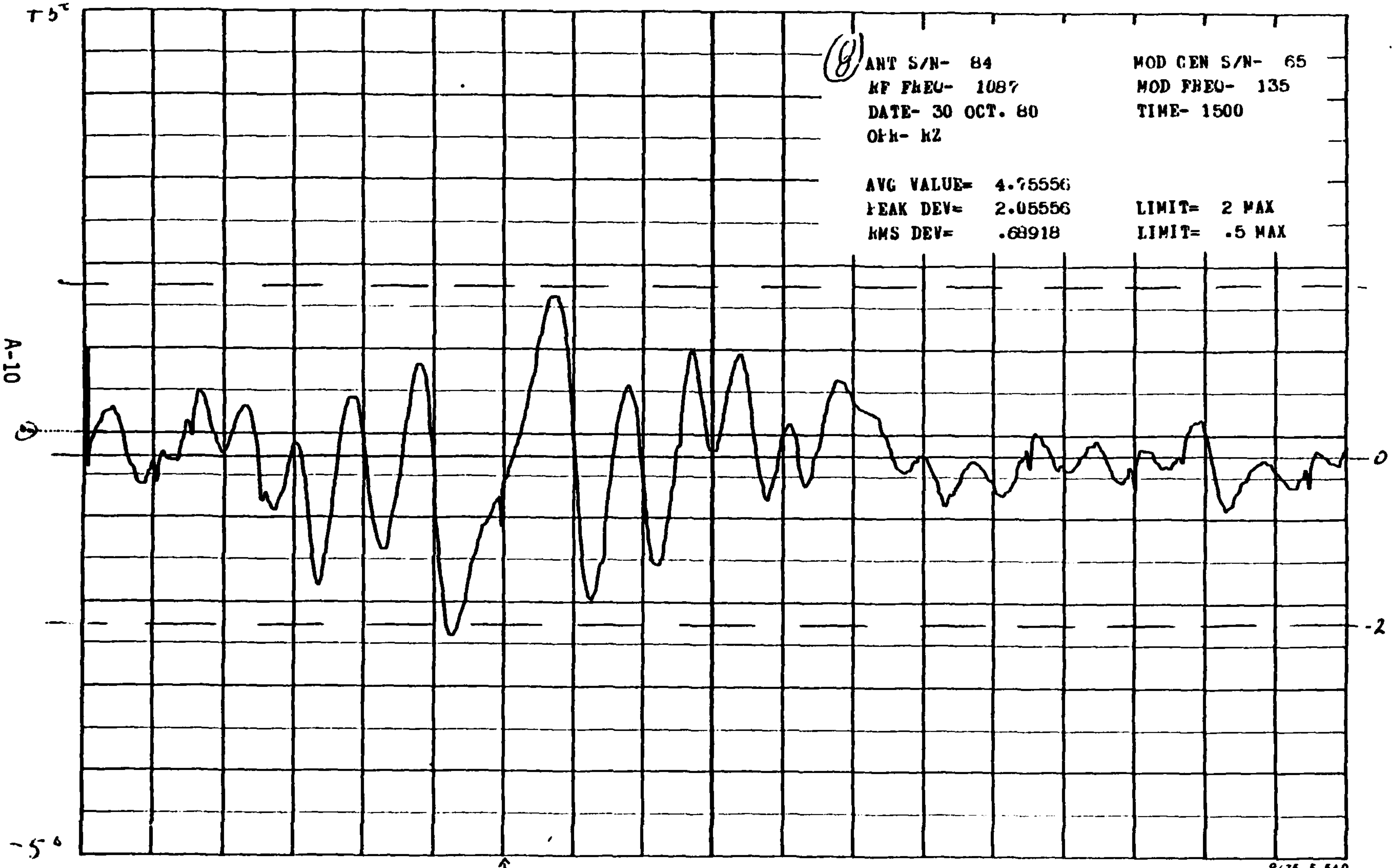


Figure A-8. Col 1 Cable Disconnected

Date

(9)

Variable 135Hz ϕ vs Az — Fixed Angle EL = 90° — Frequency 1087 MHz

Antenna S/N 084 — Compensation Switches Y H1 — Operator RZ

Generator S/N 065 — Comments: SHORT PIN DIODES, COL 1 & 2 — Witness

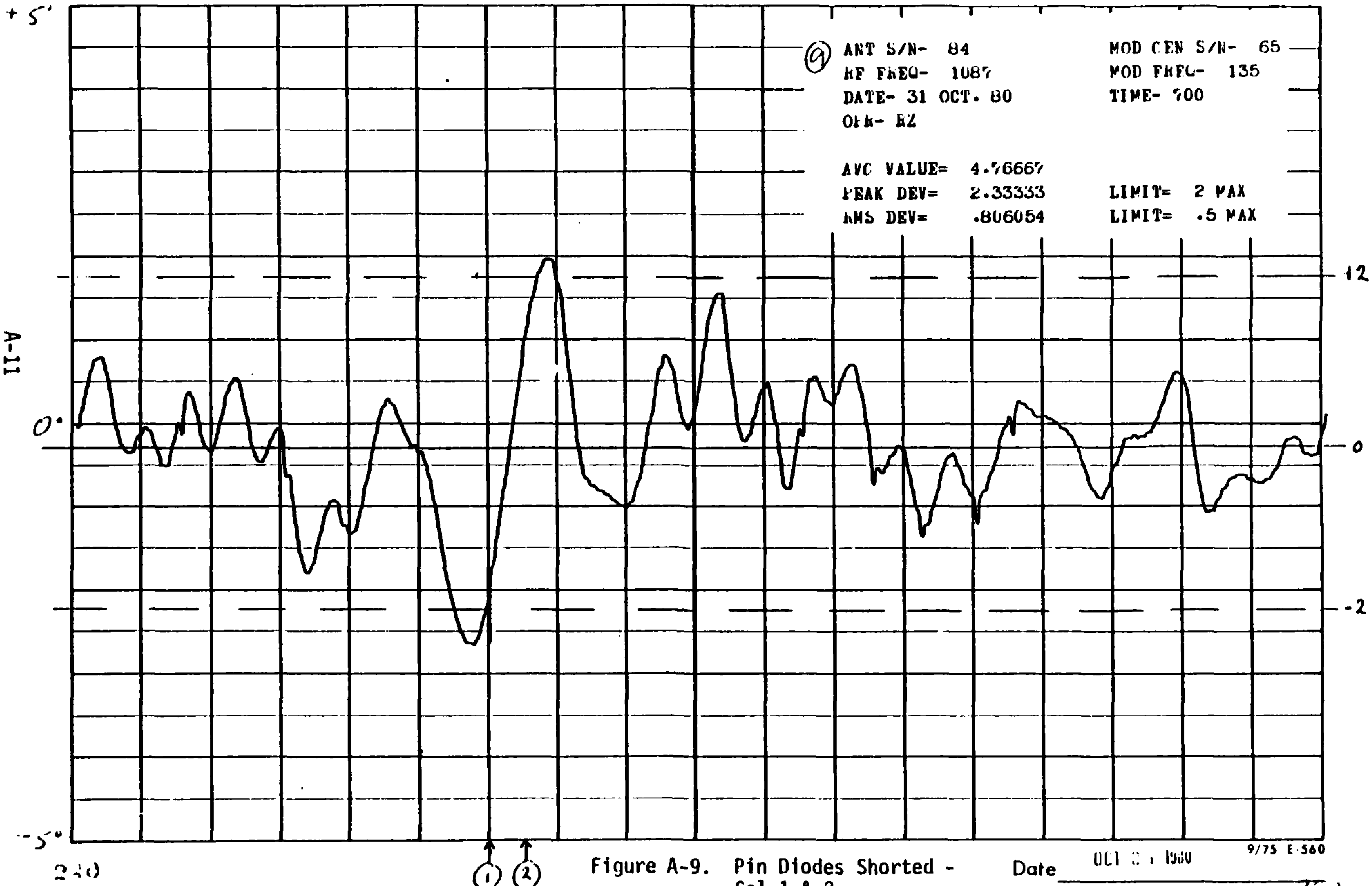


Figure A-9. Pin Diodes Shorted - Col 1 & 2

Date OCT 1980

(10)

Variable 135 Hz ϕ vs Az
Antenna S/N 084
Generator S/N 065

Fixed Angle EL: 90°
Compensation Switches Y Hi
Comments: Short Pin Diodes, Col 1 & 4

Frequency 1087 MHz
Operator RZ
Witness

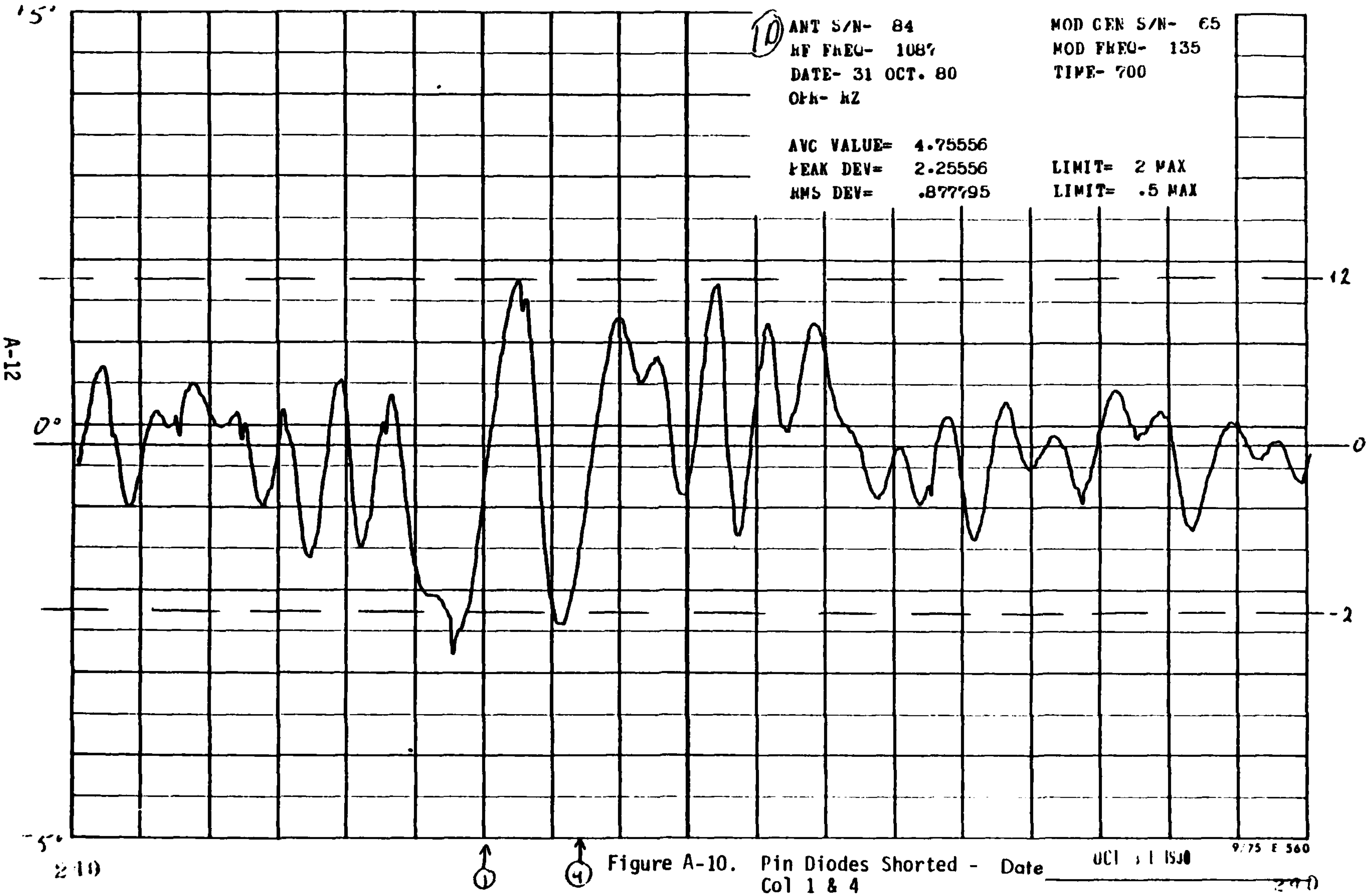


Figure A-10. Pin Diodes Shorted - Col 1 & 4

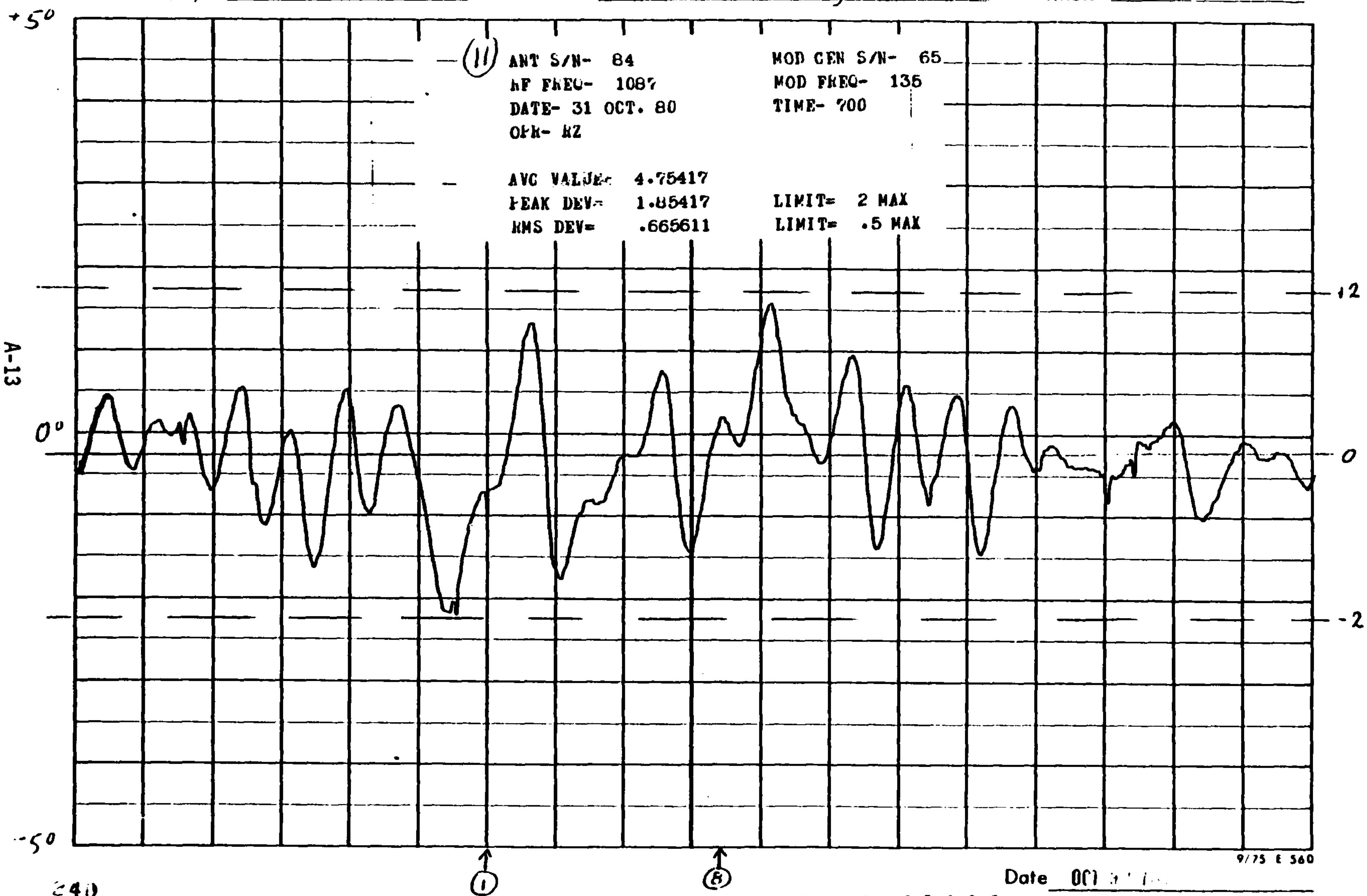
Date OCT 31 1980

(11)

Variable 135Hz ϕ vs Az
Fixed Angle EL = 90°
Frequency 108? MHz

Antenna S/N 084
Compensation Switches Y HI
Operator RZ

Generator S/N 065
Comments: SHORT PIN DIODES, COL 1 & 8
Witness



Date OCT

Figure A-11. Pin Diodes Shorted - Col 1 & 8

2 70

(12)

Variable 135 Hz ϕ vs Az — Fixed Angle EL = 90° — Frequency 1087 MHz
Antenna S/N 084 — Compensation Switches Y H1 — Operator RZ
Generator S/N 065 — Comments: SHORT PIN DIODES, COL 1 & 19 — Witness

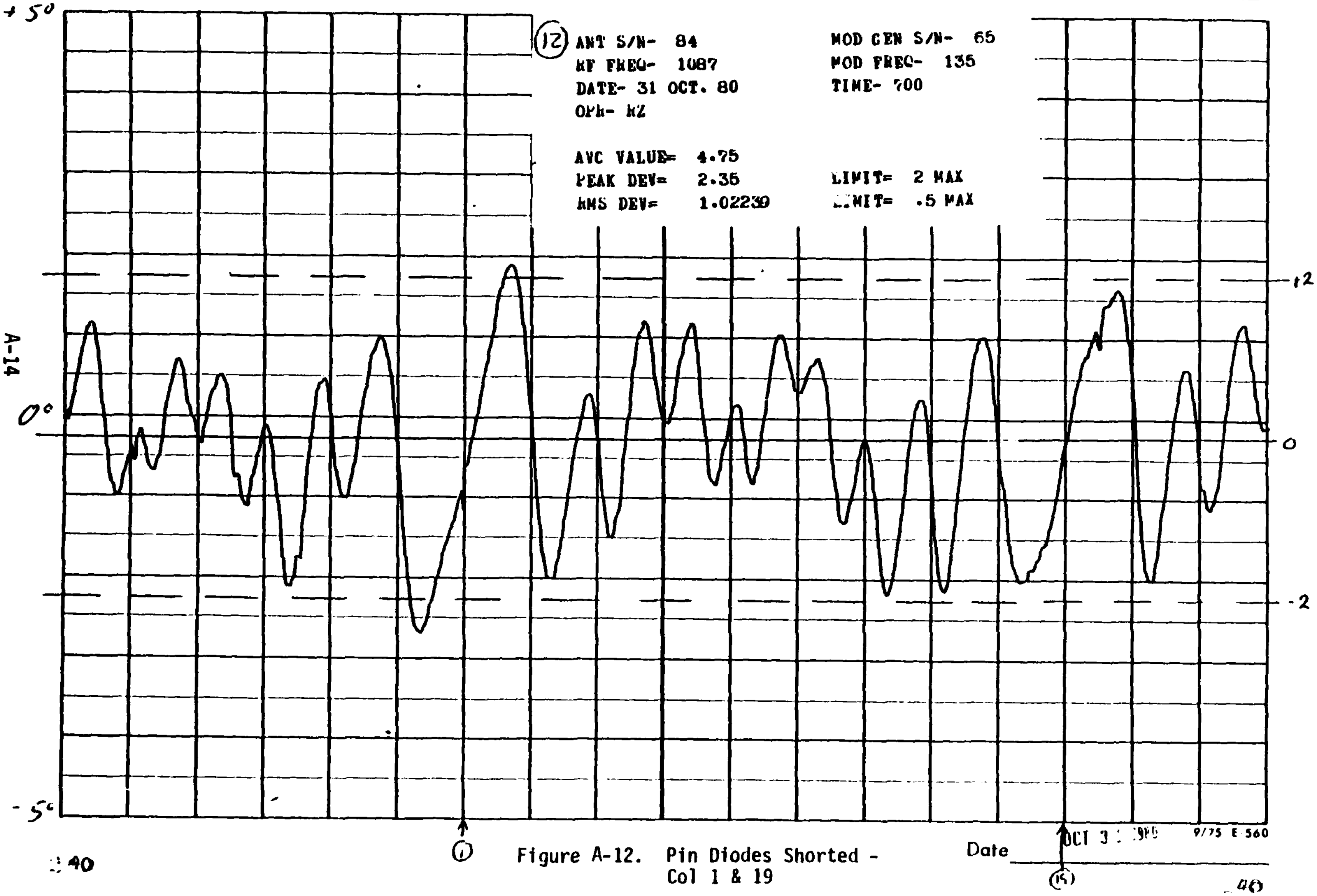


Figure A-12. Pin Diodes Shorted - Col 1 & 19

Date OCT 3 1980

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8